August 26, 1961

Chemical Week

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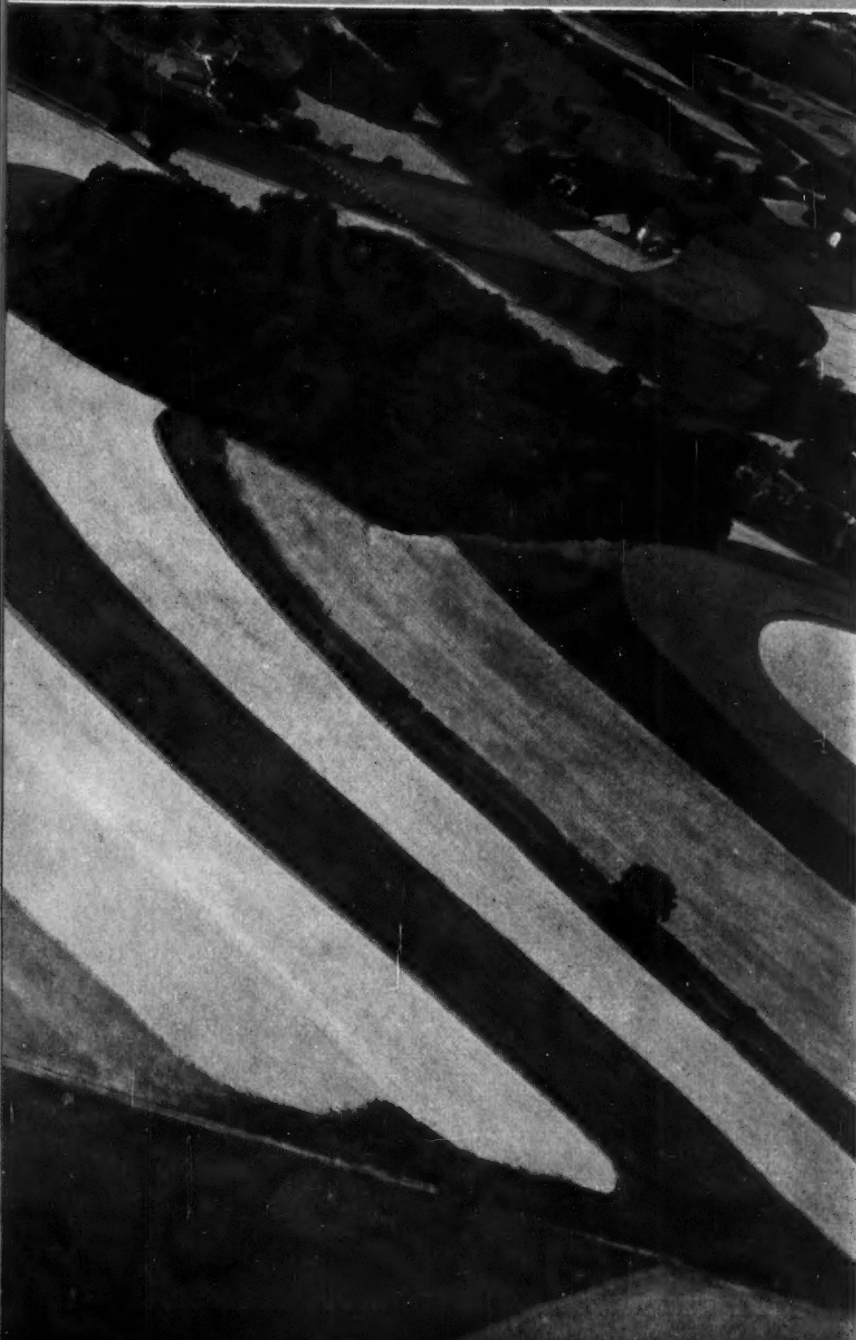
WORLD NITROGEN

Special Report . . . . . . p. 33



Beefed-up space effort will swell markets for propellants, structural materials . . . . . p. 21

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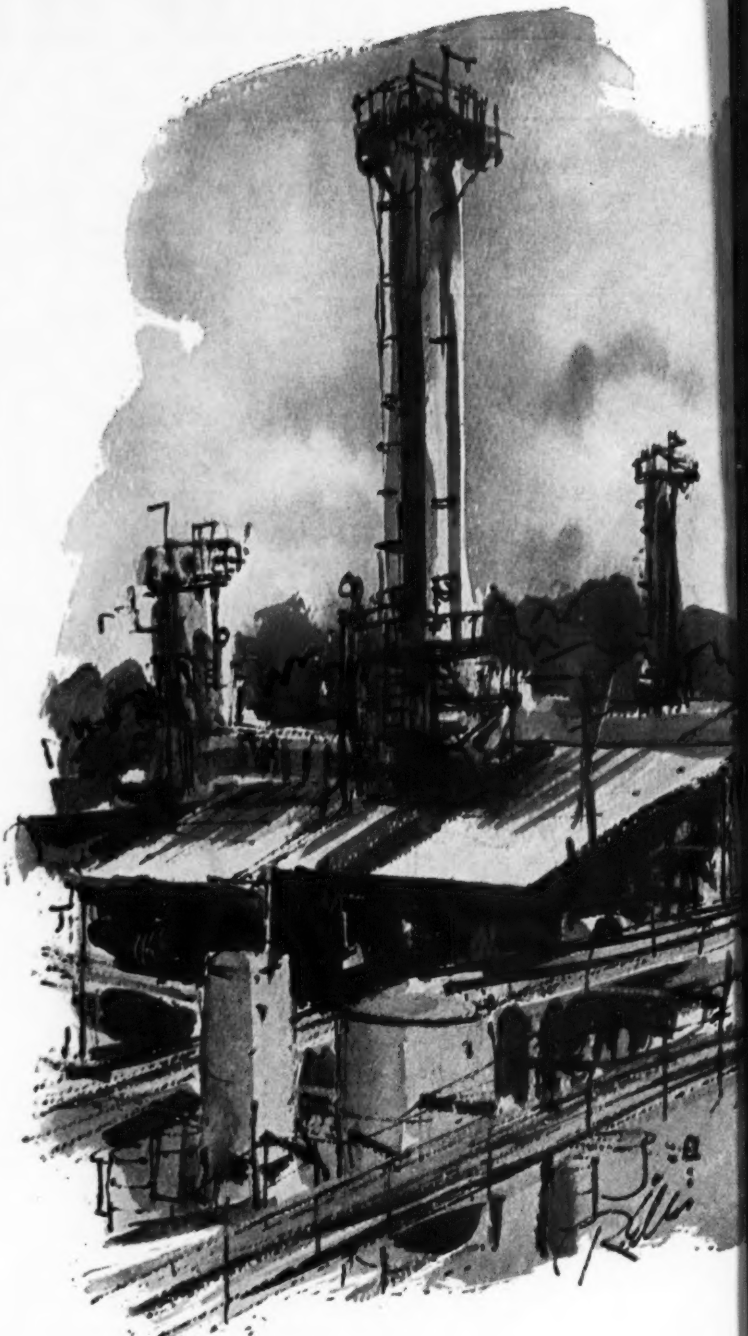
Streamline steamlines —new control can cut costs of process steam . . . 75



ON THE COVER: The rich, rolling farmland in this aerial view represents world nitrogen's major outlet—agricultural fertilizers, which consume about 90% of total N output (p. 33).

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Chemical Week

Vol. 89, No. 8 **AUGUST 26, 1961**

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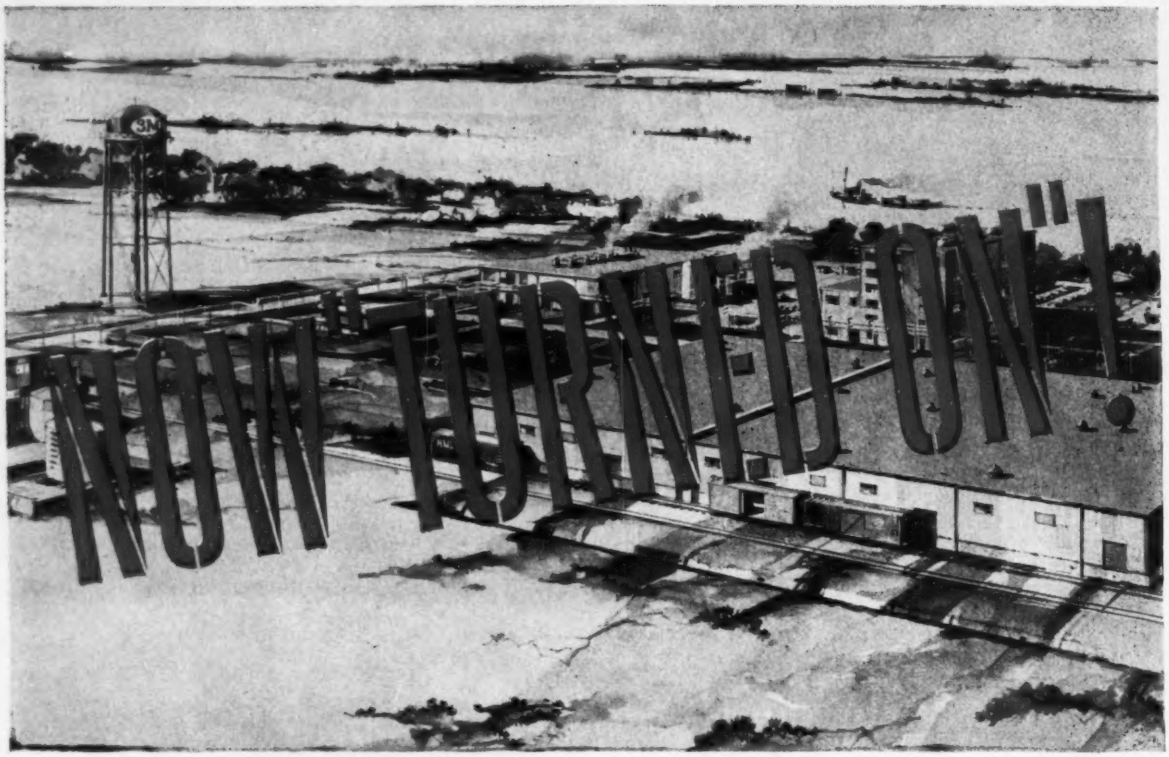

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Can We Lick Low Prices?

OF THE 46 chemical companies whose six-months' figures were tabulated last week (*CW, Aug. 19, p. 24*), 20 enjoyed higher sales vs. the first half of '60; but only 11 realized a better net income after taxes; and a mere eight improved their profit margins.

Although it appears that profit margins for the second quarter were better than for the first quarter, the fact remains that quarter-to-quarter variations are unimportant compared with the long-term trend—evident now for several years—toward lower average margins.

There are those who contend that the chemical and allied industries should be the last to kick, since their margins are generally better than other manufacturing industries'. But these critics are unaware of—or choose to ignore—the especially deleterious effect of our current depreciation policy (*see Viewpoint, Aug. 19, p. 7*) on growth industries such as ours, which must replace rapidly obsolescing facilities with continually eroding dollars; and they overlook the high cost of innovation, through research and development, that a company must undertake in order to remain competitive in an era of rapidly changing technology.

While a better depreciation law would help, the industry should look not to the government but within itself for the major attack on the problem—and that attack boils down to proper pricing. For many products, overcapacity has led to unrealistic and damaging price wars.

What can be done? The ideal answer, of course, is to have a unique product developed through one's own research. Under such circumstances the price can be set realistically, balancing size of market vs. profit per unit, to bring the greatest return.

Next best answer is to have not a unique but clearly superior product. Users of oriented polyolefin film are willing to pay a premium for one producer's material, we are told, simply because it's better than others.

Faster deliveries, better technical service, easier credit terms and other services may also help maintain a reasonable price structure, but these devices may prove illusory in that they may cost more than a simple price cut.

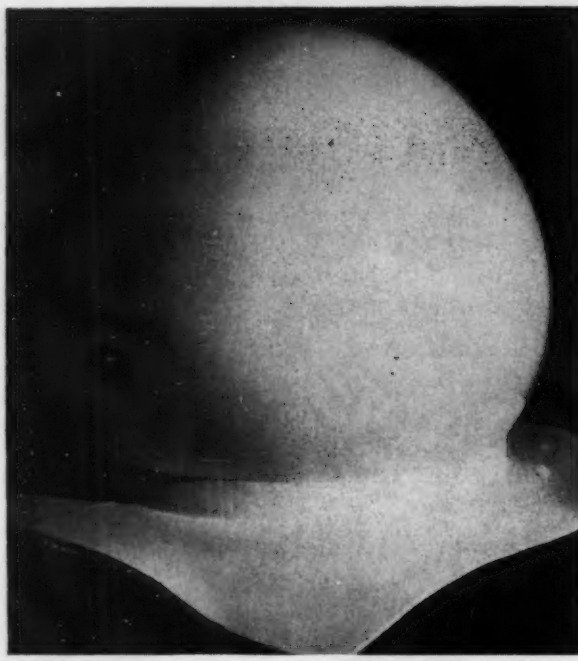
None of these avenues, unfortunately, leads to utopia for the standard chemical commodities like benzene, phthalic anhydride, polyvinyl chloride or ammonia, where the material from different producers is virtually identical. And it is in this area that the toughest and most persistent problems arise.

One obvious exhortation, which sounds like a preachment, is to have the courage to resist panic. Supposing one producer of a chemical, who has 5% of the total U.S. capacity, drops the price to an unprofitable level. Should the producers of the other 95% blindly follow suit? Or should they let him have his minuscule share of the business at the lower price?

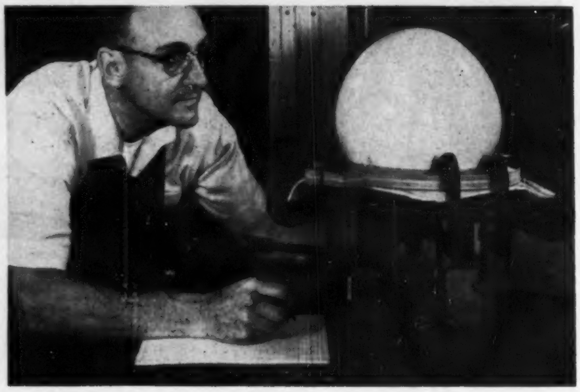
But this raises the problem that such a decision by the majority of producers implies collusion. And while collusion may look like the easy answer to many price problems, it has the double disadvantage of being illegal and leading in the long run to stagnation.

There have been many calls for "industrial statesmanship," but what does it mean? When a salesman and a purchasing agent are dickering over a carload, philosophy seems less important than getting the order.

In short, we're baffled. The industry knows—and we know—that the problem is serious; but we have neither heard nor read of any practical, down-to-earth solutions. Let's have your opinions, and we will be glad to promulgate them for the benefit of the industry.



PVC sheets (12"x12"x1/8") were heated for 4 min. at 350°F., then subjected to gradually raised air pressure. *Upper left:* Sheet containing 10% ACRYLOID® K-120N flowed easily to form smooth sphere. *Upper right:* Unmodified PVC (high pressures cause sample to tear). *Lower right:* Fixture used for applying air pressure.



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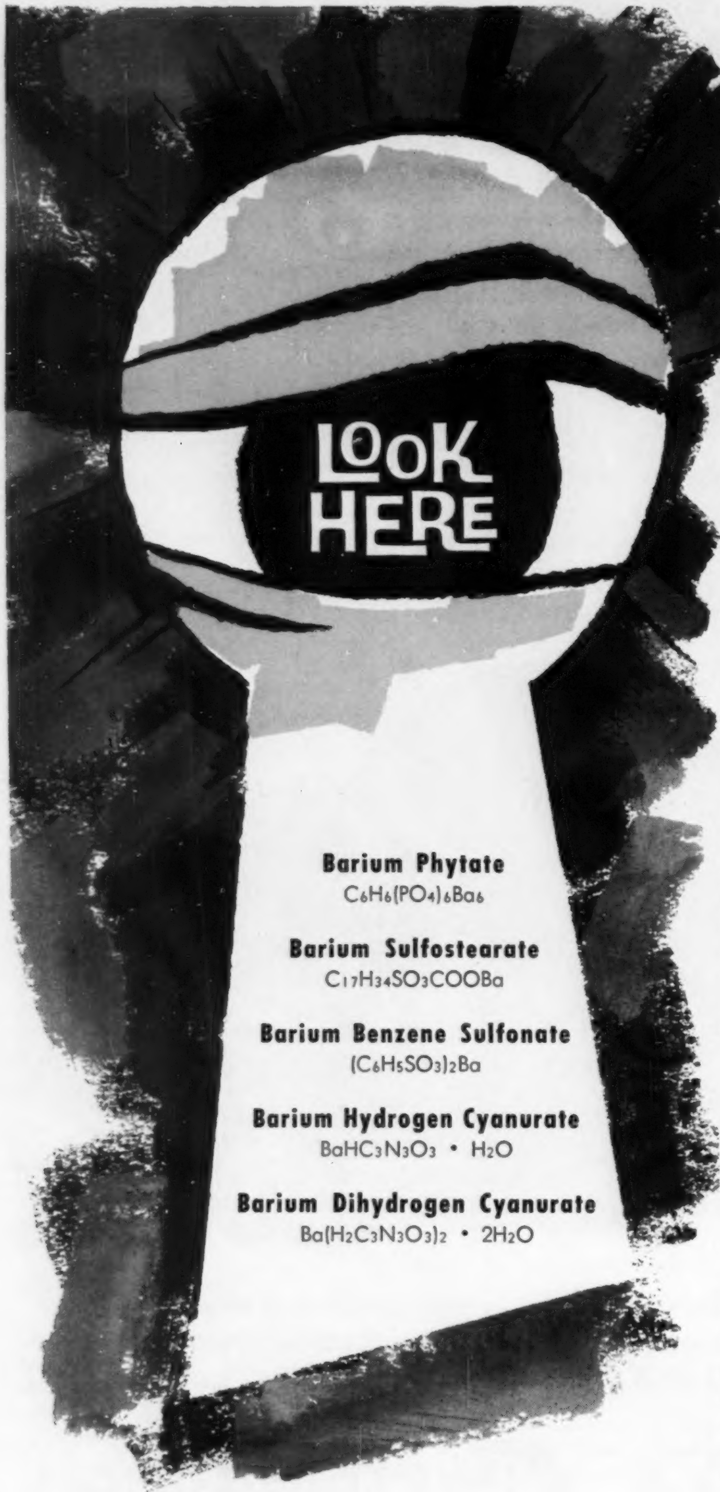

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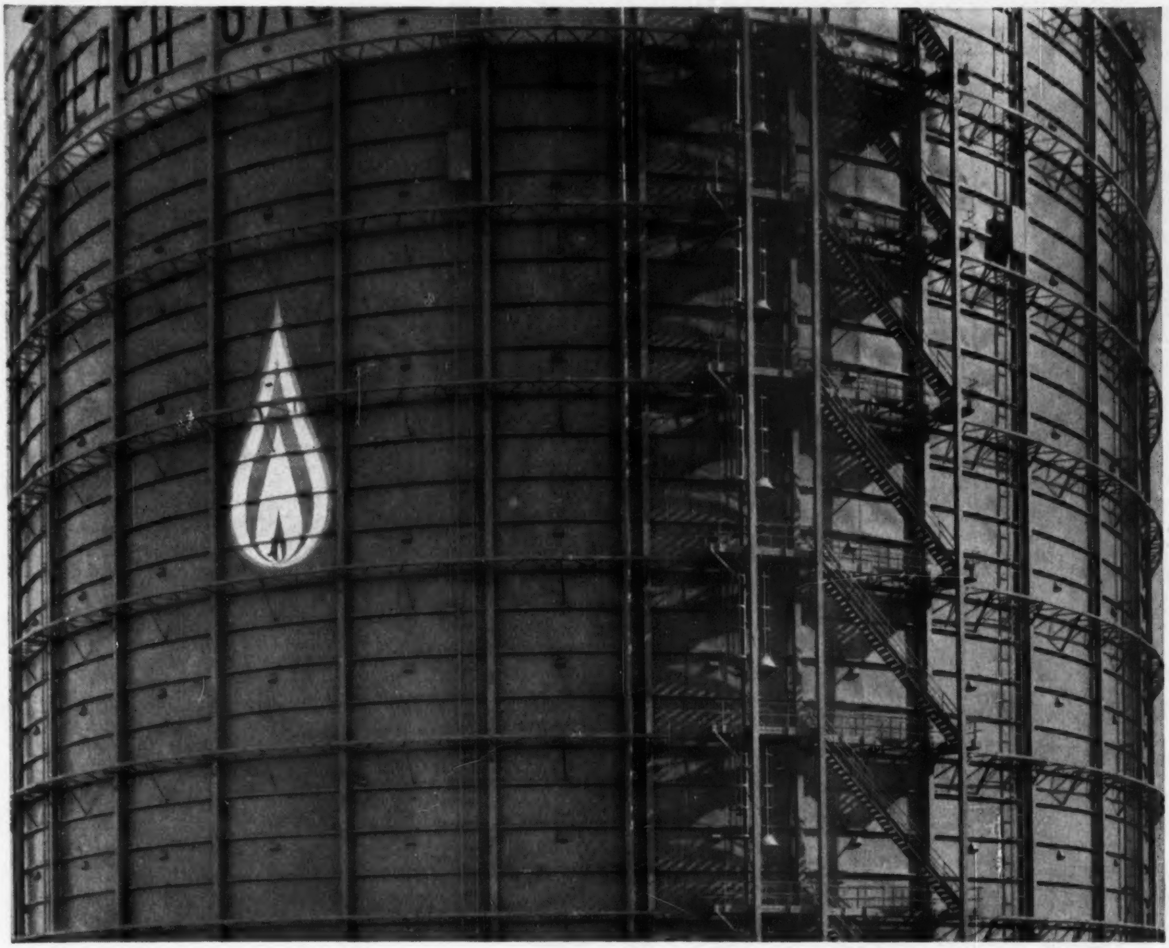

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JEFFERSON CHEMICALS

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Business
Newsletter

CHEMICAL WEEK
August 26, 1961

Antitrust lightning again hits antibiotics. Three of the nation's leading pharmaceutical makers were cited again last week when a federal grand jury in New York handed down a three-count antitrust indictment against Pfizer, American Cyanamid and Bristol-Myers, and their top executives. Olin (E. R. Squibb), and Upjohn were named as co-conspirators but were not indicted on the charges of fixing artificially high prices and monopolizing patents on tetracycline, Aureomycin and Terramycin, antibiotics.

Denials by the three officers named (Pfizer's John McKeen, Cyanamid's Wilbur Malcolm and Bristol-Myers' Frederic Schwartz) were quick and unequivocal and expressed confidence that court trial will lead to complete exoneration.

The antibiotics industry has been poked and probed for years. In his formal statement on the charge, Malcolm notes that three of the investigations—by the grand jury, the Kefauver committee and the Federal Trade Commission—are now going on.

The same five companies were named in a '58 FTC complaint that charged price-fixing of the same three products. Hearings have been completed on this complaint, and an initial decision by an FTC hearing examiner is being awaited.

Prescription sales of the antibiotics listed (plus Parke, Davis' Chloromycetin, which was not included in the charges) totaled "at least $250 million in '59," claims the new indictment.

Maximum penalty for conviction on each count is $50,000 and a year in prison for individuals, and $50,000 for each corporation.

The big question: Will this newest case in the Justice Dept.'s drive against "price fixing" turn out like the electrical equipment manufacturers' case last winter, leading to fines and jail sentences; or will it be more like the one against the polio vaccine producers, who won full acquittal? The people involved insist it will be like the polio vaccine case. "There is no evidence of (price collusion) agreements here," one official declared. After 10 years of investigations, says Cyanamid's Malcolm, the government has turned up "only some very dubious inferences."

•

Mississippi will get the $125-million refinery that will be built by the projected Standard Oil of California-Standard Oil of Kentucky combine. Site approved: Pascagoula, Jackson County.

The Mississippi legislature is meeting in special session this week to pave the way, via constitutional amendments for the project that may eventually be the center of a huge petrochemical complex. For one, the state constitution will be amended to permit 10-year tax exemptions (to compete with benefits offered industry by Louisiana and Alabama).

Business

Newsletter

(Continued)

Design and construction of the new 100,000 bpd refinery will begin immediately after stockholders of the two companies, meetings in San Francisco and Louisville Sept. 7, vote on approval of the merger.

•

Big detergent bid in Britain. Unilever Ltd. is offering about $7 million for the capital of Pinoya Holdings Ltd. in a bid for the lion's share of Britain's $28-million/year dishwashing detergent market. Pinoya owns Domestos Ltd., whose liquid detergent products now account for an estimated 20% of the country's sales. Unilever at present, also has about 20% of the market.

Unilever's offer (cash and shares) has reportedly been accepted by Pinoya's directors and friends who own at least two-thirds of the firm's 1,860,400 shares. Formal offer to Pinoya stockholders will be made by Unilever in about six weeks.

•

Out of Toronto, Can., come more details on British American Oil's recent acquisition of a 25% interest in Shawinigan Chemicals Ltd. Involved was a cash payment of about $12 million and transfer to Shawinigan Chemicals of B-A's half interest in B.A.-Shawinigan Co. Ltd. In addition, three B-A officers have been appointed to Shawinigan Chemicals' Board: E. D. Loughney, B-A president; D. L. Campbell, executive vice-president; and J. W. Morgan, vice-president.

•

Add another nitrogen products venture to the growing U. S. list (*see Nitrogen Report, p. 33*). Swift & Co. and Skelly Oil have formed 50-50 owned Hawkeye Chemical to build and operate a $10-million, 300-tons/day plant near Clinton, Ia. Principal products will be ammonia, nitric acid, nitrate solution, ammonium nitrate, urea and nitrogen solutions.

•

Commercial Solvent's net earnings are improving steadily this year compared with last, despite a lower sales volume. Reason: major emphasis on profitable areas of operations. In last week's report on chemical companies' first-half earnings (*CW Aug. 19, p. 24*) Commercial Solvents' data were inadvertently transposed with those of Devoe & Raynolds, implying a different picture. The financial data on both firms (all dollar figures in millions):

Company	Sales: 1st half 1961	Sales: Change from 1st half '60	Earnings: 1st half 1961	Earnings: Change from 1st half '60	Profit/sales ratios: 1st half 1961	Profit/sales ratios: 1st half '60
Commercial Solvents	$32.6	Down 5.1%	$2.84	Up 8.6%	8.7%	7.6%
Devoe & Raynolds	30.9	Down 7.7%	0.94	Down 21.0%	3.0%	3.5%

Spencer Chemical earnings were up 2.5% and ATCO Chemical-Industrial's earnings were down 5.8%. Those two figures in the chart covering companies reporting fiscal year results were also inadvertently switched.

Shell has three benzene-producing refineries, located near waterways. Barges like these will carry the bulk of 1961's record output.

Solid Fuels Move Up in Space Race

U.S. manufacturers of solid-fuel rockets this week are busy with plans for further tests aimed at landing key development contracts in the nation's newly launched all-out push in the space-booster field.

On the West Coast, United Technology Corp. (Sunnyvale, Calif.) recently static-fired a 250,000-lbs.-thrust solid-fuel segment (*see cut*) and Aerojet-General (Azusa, Calif.) has tested a 500,000-lbs.-thrust unit — both units due to play a big part in the beefed-up program. Aerojet now is said to be preparing a repeat test in the immediate future.

Solid-fuel propulsion now seems to be getting big play for the new huge boosters, after long settling for a role supporting liquid-fuel systems. President Kennedy paved the way for this dramatic switch last May when he ordered development of a big solid-fuel rocket booster to compete with liquid propulsion in powering a manned moon expedition.

The switch doesn't mean a hunt for new chemicals — simple propellant mixes of such materials as ammonium perchlorate (oxidizer), urethanes or polybutadienes (binder) and metals (fuel) are in currently tested engines.

The Presidential action also made itself felt in the competition between the military and the National Aeronautics and Space Administration. By selecting the Air Force to develop the big solid booster, the White House gave that service the go-ahead in an area it has been clawing to invade since President Eisenhower limited military boosters to 1 million-lbs. thrust class.

At that time, NASA was handed responsibility for developing the really big rocket boosters that hold the key to long-range space exploration. The military abided by, but never liked that decision.

Abrupt Turnabout: For the past year or so, companies have been promoting their pet theories on how to build big solid-fueled boosters. Company officials have paraded to Washington trying to persuade the government to pump money into solid rocketry. For the most part their claims that big, multimillion-pound-thrust engines can be built quicker and cheaper with solid fuels than with liquid ones has had little effect. But the situation has changed abruptly.

The Administration, now publicly committed to a race to the moon with Russia, does not want to be tied to one propulsion system. The plan now is for open competition, with the selection of propulsion system held off for another two or three years.

Right now, CPI firms are counting on heavy spending in the solid-fuel industry. The top liquid-fueled contender is the 1.5-million-lb.-thrust F-1 engine under development since 1959 by Rocketdyne Division of North American Aviation.

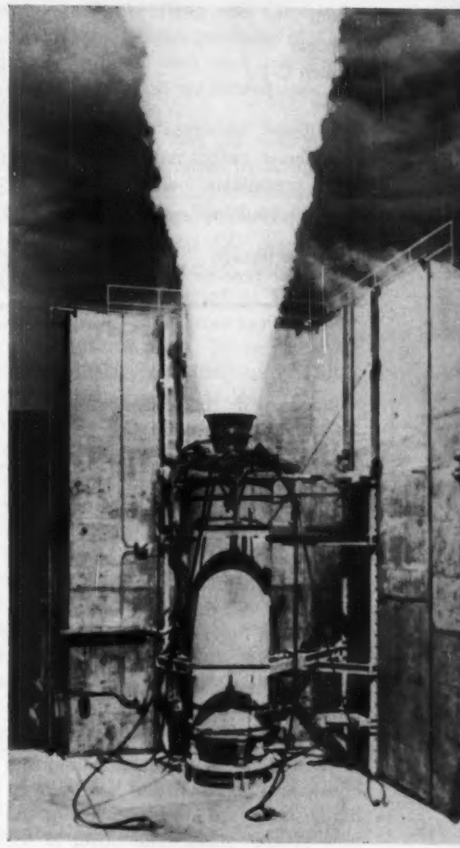
A cluster of eight F-1's can produce the 12-million-lb. thrust needed to send the three-man Apollo vehicle on a journey to the moon. The package would also include a return propulsion system and 20 tons of equipment to be left on the moon for future expeditions.

New Sites Needed: Several of the contenders in the solid-fuel field, including Aerojet-General, Grand Central Rocket and Thiokol, are reportedly looking for new plant locations. They realize that NASA must find a relatively isolated new launching location when it starts shooting the huge new boosters, and they want to build reasonably near the launching site.

Congress voted some $4 million this year for site inspections and preliminary engineering work for this project, but NASA has not committed itself on a location. Texas' Gulf Coast, however, seems to be a strong candidate for the new range.

The noise problem is the main reason for seeking a new location. Experts predict shock waves set up by the blast of a 12-million-lbs. thrust class vehicle would shatter windows for 25-30 miles. Another contributing factor: the growing congestion of Cape Canaveral.

The Air Force estimates that it will take between $1 billion and $2 billion to develop a solid-fuel booster of this class, so companies will not hesitate



Coming soon: more tests of solid-fuel engines, such as this UTC rocket.

to build new plant sites. The Air Force will spend $62 million directly on this program alone during the current fiscal year; and indirectly, an estimated $100 million will go toward solid-fuel booster technology. Once the booster is developed, production will involve fat contracts as well.

All told, military spending for solid-fuel research and development in fiscal '61 has been estimated at more than $500 million. Most of it was in the area of missile development—such projects as extending the range of the Navy's Polaris to 2,500 miles in the A-2 and A-3 series, and the Air Force's Minuteman ICBM program.

But the future of the chemical rocket industry lies in space boosters, not missiles. Missiles now being de-

R&D Spending for Chemical Rockets

(All cost figures in million dollars)

Booster	Cost Through Fiscal '61	Planned for Fiscal '62	Completion Date	Payload Capability *
Nova	——	48.5	'67-'69	50-75 tons
Scout	13.5	3.7	'62-'63	150 lbs.
Centaur	103.2	56.4	'63-'64	8500 lbs.
Saturn C-1	175.3	224.1	'63	19,000 lbs.
Delta	36.9	2.9	'61	500 lbs.
F-1 (thrust: 1.5 million lbs.)	64.2	57.3	'65	——
J-2 (thrust: 200,000 lbs.)	16.7	28.7	'64	——
Solid propulsion (NASA)	3.6	3.1	——	——
Solid propulsion (Military)	1,000.0 (est.)	over 500 (est.)	——	——
Storable liquids (Mainly for Titan II)	several million	several million	——	——

* Nova payload capability is for escape; others for earth orbit.

veloped will reach the production stage in the next couple of years. Orders will be sizable, but once the nation's arsenal is outfitted with ICBMs, production will drop sharply. Space probes are another matter. The race has just started and faces no limit like the one in the missile field.

Liquids Still Strong: The space age has been a boon to the liquid-propellant industry. And although solid fuels seem to have taken over with the military and are bidding to do the same with the civilian field, NASA is committed to numerous liquid-fuel boosters. Plans call for hundreds of liquid-fuel space experiments over the next several years. The Scout is the only solid-fuel rocket on deck for space experiments.

NASA originally turned to liquid fuel for its space program because technology in this field was further advanced. There is still strong interest in liquid fuels at NASA. But if solids can start matching the performance of liquids, the agency says it will take a hard look at them. Two factors favoring solids: low initial cost, simplicity. As one NASA spokesman put it, "If we could reduce the long, trying countdowns it would be a giant step forward."

In the present state of the race, the emphasis is on getting the job done, not necessarily finding the optimum concept. Companies with experience and proved ability for successful program management will have a decided advantage. Some industry observers feel that this thinking will tend to de-emphasize the government's traditional efforts to spread the work around.

The Pentagon's Case: The battle of the propellants involves more than technical factors. A hard core of the military has always resented being legislated out of the space program. Many make no bones about saying it could be run better from the Pentagon than by NASA. It has been military-developed rocket boosters that have carried the space program along, they are quick to point out. In fact, the F-1 engine, due to be in service by '65, is the first booster fully developed by NASA. The Saturn, for example, was started by the military and transferred to NASA. It uses improved engines developed for the Atlas, Thor and Jupiter missiles.

The Centaur (*see chart*), too, uses Atlas engines. And the Delta uses a production model of the Thor IRBM, less the nosecone and guidance system, as its first stage.

The military branches have ambitious space programs of their own that will require large rocket boosters. If they were to develop the booster used to carry man to the moon, it would be a big prestige factor for them, in their race with NASA. Thus, many industry and military spokesmen privately say that no expense will be spared by the Air Force to build the big Nova engine.

But regardless of whether NASA or the Air Force gets the top hand, and regardless of which propulsion system — solid or liquid — wins out, the chemical industry will carry a big share of the work load.

Rising Sales Foreseen

Optimism that production and sales will continue to rise above the peaks just attained is a recurrent theme in chemical companies' late financial statements.

Procter & Gamble reports record sales and earnings for its fiscal year ended June 30. Sales mounted 7%, to $1,541.9 million, and net income climbed 9%, to $106.6 million.

For that same fiscal year, American Agricultural Chemical boosted sales 7.5%, to a record $96.7 million, and raised earnings 6.6%, to nearly $3.8 million.

Minerals & Chemicals Philipp Corp. does not report interim sales data, but six-month earnings rose 5%, to more than $4.5 million.

For Kawecki Chemical, half-year sales and earnings — both records for the company — were up 52%, to $5.8 million, and up 36%, to $472,138, respectively.

De Soto Chemical Coatings lifted half-year sales 5.3%, to $28.9 million, and earnings inched up 0.5%, to nearly $1.7 million.

Metal Decisions Due

Decisions on new aluminum and brass projects fall due next month.

National Distillers and Chemical Corp.'s newly merged Bridgeport Brass Co. Division is now joining Cerro Corp. in feasibility studies on the proposed 56,000-tons/year aluminum reduction plant for Wauna, Ore. (*CW Business Newsletter, July 8*). If all signs prove favorable, the two companies will set up a 50-50 joint subsidiary to carry out the $50-million project. An electric power agreement with Bonneville Power Administration provides for a $100,000 penalty if the pact is canceled or the site is changed before Sept. 30.

Harvey Aluminum also is supposed to make up its mind before Sept. 30 on whether to proceed with an aluminum expansion in Bonneville territory (*CW, July 22, p. 27*). Harvey, however, is also considering a primary aluminum plant — possibly using a direct-reduction process — in Nova Scotia.

Canadian British Aluminium has decided to add one potline to its Baie Comeau smelter, starting in '63 and ending in '65. This will increase ca-

pacity 50%, to 135,000 tons/year (*CW Business Newsletter, Aug. 19*). Nearly all of CBA's output goes to its principal parent company, British Aluminium, which in turn is 47% owned by Reynolds Metals (Richmond, Va.)

Far Eastern Move: And Reynolds is moving into the Japanese aluminum market. If the Tokyo government approves a proposal submitted last week, eight Mitsubishi firms and Reynolds will organize a joint subsidiary to be known as Mitsubishi-Reynolds Aluminum Co. In the spring of '63 it will start producing aluminum sheets, plates, cans, powder and wires for Japan and southeast Asia.

Olin Mathieson Chemical — whose aluminum operations have been "in the black" for the past nine months — is undertaking a multimillion-dollar expansion and modernization of its Olin Brass Division. This program — to be completed early in '64 — calls for an entirely new casting and rolling plant in East Alton, Ill.; replacement and modernization of various units at East Alton and New Haven, Conn.; and modernization of fabricating facilities.

Merge One, Buy One

Next week, Diamond Alkali Co. (Cleveland) is slated to consummate its merger with Bessemer Limestone and Cement Co., as authorized last week by stockholders of both concerns.

Chemical Process Co. (San Francisco) also is coming into the Diamond organization, but not by merger (*CW Business Newsletter, Aug. 12*). At present, Chempro is operating as a more-than-90%-owned subsidiary. When and if Diamond can buy up the remaining shares of Chempro stock. Chempro operation will be made part of the Diamond operation.

Diamond's stockholders approved the proposed change in capitalization. The company still has 4.5 million authorized shares of par $10 common stock; but instead of the previously authorized 250,000 shares of par $100 preferred stock, it now has 500,000 authorized shares of no-par-value preferred stock. Diamond next month will issue 270,808 shares of the new preferred stock and exchange it for the 812,424 outstanding shares of Bessemer common stock.

Jersey Gas Turnpike

Air Reduction Co. (New York) is extending its "over-the-fence" marketing of nitrogen and oxygen in the Delaware Valley chemical complex.

Airco will lease a 22-mile pipeline SunOlin Chemical plans to build to supply several chemical plants in the area. SunOlin will take 150 tons of nitrogen and 100 tons of oxygen daily. Airco's products will come from the $6.5-million air-separation plant it is constructing at Claymont, Del. (*CW, March 11, p. 24*). Completion target for both projects: second-quarter '62.

The 8-in. nitrogen line (capable of handling gas at pressures to 900 psi.), one of eight SunOlin will build, will cross the Delaware River and extend 12 miles north to Shell Chemical's polypropylene plant at Woodbury, N.J., and 10 miles south to Du Pont at Deepwater Point, N.J. Taps—for new customers—will be built every two miles. Shell and Du Pont will take 100 tons of oxygen daily.

Daily capacity of the separating plant: oxygen, 350 tons; nitrogen, 400 tons; argon, 12 tons. Airco will add a hydrogen unit at Claymont, using SunOlin crude hydrogen.

This multiproduct, multicustomer distribution setup is similar to the supply scheme Union Carbide's Linde Division is building in the Houston Ship Channel area (*CW, Oct. 22, '60, p. 65*).

Purex Takes Its 10th

Purex Corp. (South Gate, Calif.) is snowballing again. Its newest acquisition—the 10th within the past six years—is Potter Drug and Chemical Co. (Malden, Mass.), producer of Cuticura ointment, soap and other nationally distributed medicated specialties.

Purchase price was $3 million in cash, which Purex raised by selling to a group of institutional investors subordinated notes convertible into Purex common stock at $85/share. (In over-the-counter trading last week, Purex stock was quoted at $70 bid, $74¾ asked.)

This move gives Purex its first manufacturing and distribution facility in New England, and adds about $3 million/year to Purex sales volume. Purex's preceding acquisition—T. F. Washburn Co. (Chicago), producer of paint base, varnishes and protective coatings, obtained last May by exchange of stock—pushed annual sales past the $100-million mark. Purex President A. C. Stoneman estimates turnover for the fiscal year ended June 30 at $102 million, with net income up 25%, to $4.3 million.

Du Pont Takes Partner

Du Pont is launching its third joint venture in Europe. With Etablissements Kuhlmann (Paris), it is forming a 50-50 subsidiary to build an isocyanates plant at Kuhlmann's La Madeleine plant site near Lille.

In times past, Du Pont had a wholly or majority-owned policy on foreign investments. This has been modified in recent ventures in line with changing factors abroad and as Du Pont has stepped up its overseas investments. Now Du Pont will go into a joint venture overseas when political or economic factors "make it advisable."

Besides providing some of the $6-million capital, Kuhlmann will supply raw materials, service facilities, engineering and construction forces, and personnel to operate the plant. Kuhlmann's process and service facilities already in place made it a likely partner.

Construction of the French plant, called Dekachimie, is slated to start early next year, is due for completion some time in '63.

national roundup

Rounding out the week's domestic news.

Companies

Oxford Chemical Corp. (Atlanta) is making its third acquisition in recent months by purchasing American Chemical Co. (New Orleans), producer of industrial cleaning chemicals. Previously, Oxford had acquired S and S Chemical Co. and Avril of Florida Inc. (both of Miami).

Foster D. Snell, Inc. (New York), has bought out American Scientific Supply (Long Island City, N.Y.). However, Snell will not carry on American's laboratory supply business. American's inventory will be used by Snell's laboratories in New York City, Baltimore, and Bainbridge, N.Y.

Atlantic Research Corp. (Alexandria, Va.) has sold 115,000 shares of its stock to Television-Electronics Fund (Chicago) in a $4,025,000 private placement. Purpose, says Atlantic President Arch Scurlock, is to provide capital for continued expansion of the firm's facilities and capability for research and development in high-performance propellants and gel-solid boosters.

Owens-Illinois Glass Co. (Toledo, O.) is combining three divisions and one major subsidiary into a newly organized Forest Products Division, which will be headed by Edwin D. Dodd, 42, an O-I vice-president. Units going into the new operating division are the mill, multiwall bag, and paper products divisions and National Container Corp. of Calif. Assets include 27 plants, 36 sales offices, two railroads, and 1.2 million acres of owned and leased timberlands.

Expansion

Phosphates: National Phosphate Corp. (Marseilles, Ill.) plans a multimillion-dollar expansion that will triple its phosphoric acid capacity and permit upgrading of some of its phosphoric output to diammonium phosphate. The project also includes construction of a sulfuric acid plant and a molten sulfur terminal. Completion is expected by second-quarter '62. Financing has been arranged by the Chemical Dept. of Empire Trust Co. (New York).

Ammonium Perchlorate: Pacific Engineering & Production Co. (Henderson, Nev.) is expanding its ammonium perchlorate capacity from 7½ tons/day to 17 tons/day. The company also is building a unit to produce its total requirements of sodium chlorate, a raw material heretofore purchased; and Pacific says that some of the sodium chlorate could be marketed. The new units are to be onstream early in '62.

Foam Catalyst: Houdry Process Corp. (Philadelphia) will more than double its capacity for triethylenediamine by constructing a second plant at Paulsboro, N.J., to be completed by year-end. The product is marketed as a urethane foam catalyst tradenamed Dabco.

Acrylic Resins: Pittsburgh Plate Glass Co. (Pittsburgh) has taken an option on a 65-acre tract near Circleville, O., as a prospective site for a new central resin plant. The proposed plant would produce Duracron, Duracryl and other resins for PPG's Paint and Brush Division.

Antioxidant: U.S. Rubber Co.'s Naugatuck Chemical Division plans to build a "multimillion-dollar" plant at Geismar, La., to provide additional capacity for its Flexzone tire antiozonant-antioxidant (N-isopropyl-N'-phenyl-*p*-phenylene diamine). This plant will be adjacent to the acetylene-vinyl chloride plant being constructed at Geismar by Monochem, Inc., a joint subsidiary of U.S. Rubber and Borden Co. Onstream target: spring '63.

foreign roundup

Rounding out the week's international news.

Fertilizer/Ireland: The government of Ireland plans to subsidize construction of a $17-22-million nitrogenous fertilizer plant at Arklow, 60 miles south of Dublin. It would use pyrites from nearby St. Patrick's copper mine. If approved by Parliament, the plant would provide a base for several subsidiary industries using chemical by-products.

Nylon/India: In a three-way trade deal, Yugoslavia will supply West German-made plant and equipment for a $3.36-million nylon plant to be built in India. To save India foreign exchange, Yugoslavia will take payment in rupees. More such deals are likely.

Newsprint/India: India plans to increase production of newsprint sixfold in the next five years—from the 24,000 tons/year now produced by its single plant. Demand is expected to rise from the current 105,000-110,000 tons/year to 150,000 tons by '70. Three private plants, with a total capacity of 180,000 tons, have been approved. Until they come into production, however, India will increase imports from Russia, paying in rupees.

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Washington
Newsletter

CHEMICAL WEEK
August 26, 1961

Pfizer has gained a jump on other oral polio vaccine makers by winning a Public Health Service license to produce a live vaccine effective against Type I polio. The best educated guess in Washington is that Pfizer also is ahead in the race for licenses to produce Type II and Type III vaccine. This is still subject to change, however, since Type II vaccine will not be licensed for several weeks and Type III for several months.

Meanwhile, the government will buy the first 900,000 doses of Type I for use in event of an epidemic. Oral vaccine will not be made available generally (other than in the government stockpile) until all three types are in adequate supply—probably not before next spring. Until then, Salk vaccine rather than Sabin vaccine will be advocated for general use.

•

Kentucky will be the first state to assume regulatory controls over industrial nuclear materials and applications. Actual transfer of such authority from the Atomic Energy Commission to the state is still a couple of months off. But the AEC staff says it will recommend the move since Kentucky has worked out a program comparable with AEC's for licensing, inspecting and enforcement of state radiation safety rules.

Involved are radioisotopes, nuclear source materials (e.g., uranium and thorium), special nuclear materials (e.g., U-233, U-235 and plutonium) and nuclear materials in less than a critical mass. The Kentucky move will set a precedent for 11 other states, which have legislation permitting them to assume health and safety responsibilities against industrial radiation hazards. They are: New York, Mississippi, Texas, California, Tennessee, Washington, Oregon, Florida, Indiana, Idaho and Illinois.

•

An additional $26 million for civil defense medical supplies is sought by President Kennedy. This is included in an over-all $73.2-million supplemental appropriation request sent to Congress. Of the total, $47.2 million would go to the Agriculture Dept. for relocating 126 million bu. of federally owned wheat to areas of possible food shortage in case of enemy attack.

The $26 million for medical supplies, to be administered by the Dept. of Health, Education & Welfare, would be used to equip 2,900 emergency hospitals with enough supplies to last 30 days. Currently, emergency hospitals have an operational capability of only four days. Purchase of the medical supplies would be made by HEW rather than by the Office of Civil and Defense Mobilization.

•

The chemical industry stands to be a prime gainer from a long-range program of oceanographic research, just getting under way. More

Washington

Newsletter

(Continued)

than 700 top government and industry officials met last week to lay the groundwork for the first phase of the program—trying to determine what instruments will be needed for the research. It is estimated that between $4 billion and $5 billion will be spent in the next 10 years exploring the oceans.

The drive is sparked by the White House. The goal is to learn what economic resources can be obtained from the oceans—comprising 71% of the earth's surface. Prime potentials are chemicals, foodstuffs and, of course, usable water. One of the key roadblocks to reaping products from the sea has been a lack of research money and a dearth of instruments to assess the elements of the oceans.

•

Du Pont has taken its case to the Justice Dept. President Crawford Greenewalt met with Attorney General Robert Kennedy for what was described only as a "cordial exchange of views." Greenewalt left some information with Kennedy, which the Attorney General promised to examine—nothing more.

Although no official announcement was made, it is clear that Greenewalt was seeking Administration support for bills pending in Congress that would give Du Pont stockholders some relief from taxes they will owe after a court-ordered divestiture of 63 million shares of General Motors stock. There is virtually no chance of passage without strong Administration support, which so far has not been forthcoming. The House Ways & Means Committee heard Greenewalt's views on the subject this week (Thursday).

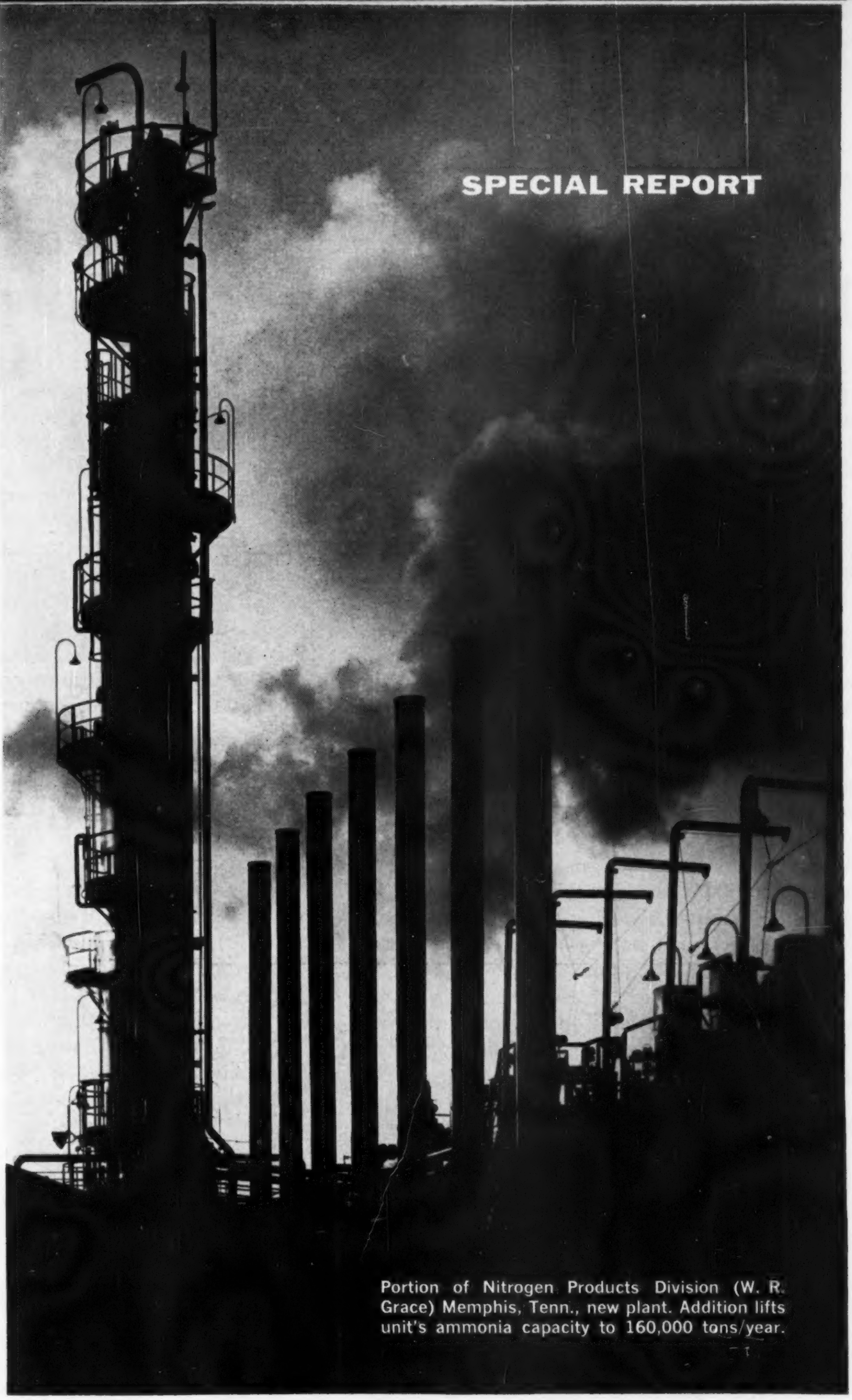
•

The Delaware River Compact has been given the green light by the Kennedy Administration. Interior Secretary Stewart Udall says the Administration will support legislation before Congress authorizes the compact—if several clarifying amendments are added. Most of the proposed amendments are noncontroversial enough to assure adoption. But one could cause a bottleneck: Udall insists that all sales of hydroelectric power generated at Delaware Compact projects be subject to public preference laws—that public utilities and co-ops get first crack at such sales.

Private utilities and their supporters will object strenuously to this and they will find active support for their stand in Congress. The House has already passed authorizing legislation without Udall's proposed amendments. The matter now is before the Senate Public Works Committee and will have to go to conference if the Senate group goes along with Udall.

•

A new president is being groomed for the American Petroleum Institute. Rep. Frank Ikard (D., Tex.) will resign at the end of this session to head API's Washington office. Ikard is expected to gradually expand his job and take over the top post when President Frank Porter retires several years hence.



Portion of Nitrogen Products Division (W. R. Grace) Memphis, Tenn., new plant. Addition lifts unit's ammonia capacity to 160,000 tons/year.

NITROGEN

There's a worldwide hustle on to build nitrogen fertilizer capacity. It means demand is climbing and world trade patterns are changing. It also means that overcapacity again may be a problem.

Nitrogen—Building to a Surplus?

World production of nitrogen, on the basis of data not yet officially substantiated, may have reached an unprecedented level of nearly 14.5 million short tons (100% pure nitrogen) during the fertilizer year (1960-61) that ended in June.

But that record may be short-lived. Indications are that present trends in nitrogen demand will lift total world production—including output in the U.S.S.R., Red China and other Soviet-bloc countries—to a new high estimated at about 15.7 million tons in this fertilizer year (1961-62) (*see table, p. 35*).

Nitrogenous fertilizers, by far the largest outlet for nitrogen, likely accounted for 12.4 million tons of the '60-'61 total. Their predicted chunk of the current year's total is nearly 13.5 million tons. Industrial nitrogen production for the first time topped the 2-million-tons mark in '60-'61 is expected to climb an additional 10% this year.

These anticipated records follow a well-established pattern of growth in nitrogen output. But while the increase in '60-'61 was probably 7%, compared with the '59-'60 crop year's 10% gain, it is nonetheless significant: the long-time gap between world capacity and world demand has apparently narrowed. More than one-third of the new increase came from higher operating rates of existing plants—underscoring the better world demand—while only a small fraction is attributed to new facilities.

Fertilizers Up: Generally speaking, world consumption and production of the major plant nutrients (nitrogen, phosphates, and potash) has steadily increased over the decades. But since the early '50s the ratio of production and use of the three has moved sharply in favor of nitrogen.

While it is difficult to assemble precise figures on world fertilizer output, a close estimate for the year ending June '61 would be 30 million metric tons, compared with about 18 million tons in '53-'54.

Of last year's total, nitrogen may have sliced out some 37%, compared with a little over 30% six years ago; phosphate (P_2O_5), 35% vs. an estimated 37%; and potash, about 28% vs. 32%.

Among the forms in which nitrogenous fertilizers are produced, ammonium sulfate and ammonium nitrates together account for slightly more than half the total production of world nitrogen. A recent study by the United Nation's Food and Agricultural Organization, based on latest available data ('57-'58) from reporting countries, shows ammonium sulfate taking about 29% and the nitrates some 25%. Nitrates, though, are now strongly challenging sulfate for the top spot. Nitrogen solutions (chiefly anhydrous ammonia, aqua ammonia, and ammonium-nitrate-water solution), which in the covered year accounted for 17% of world use of nitrogen, is on the upswing, especially in the U.S.

Over this period, North America (chiefly the U.S.) has accounted for slightly over 30% of the world's nitrogen production and perhaps 32-35% of the consumption.

Europe has consistently produced just over half of the world total, while accounting for 43-45% of the nitrogen consumption.

Although all European countries are not participants in the Organization for European Economic Cooperation (OEEC), a just-published study of fertilizers in Europe, based on reports from member countries, illustrates the general pattern of nitrogen fertilizer activity throughout the world.

Among members, says OEEC, production of fertilizers in '59-'60 showed a steady increase over the previous period. For phosphate and potash fertilizers the increases were 6% (to 3.9 million tons P_2O_5), and 7% (to 3.2 million tons K_2O). Nitrogenous fertilizers production was up 6%, to a shade under 4 million tons N.

Forecasts indicate that nitrogen fertilizer output in OEEC countries will increase 11%. Potash fertilizers are likely to maintain their 7% increase rate in '60-'61, but phosphate fertilizers may inch up only 1%.

Over-all, OEEC consumption of nitrogenous fertilizers has increased; it hit some 2.86 million metric tons N in '59-'60. The estimate for '60-'61: 3.15 million tons. But while consumption has been moving up, rate of nitrogen capacity expansion has been decreasing, bolstering the observation that in Europe, as in most other parts of the world, increased demand in the recent past has been met by better utilization of existing plant potential.

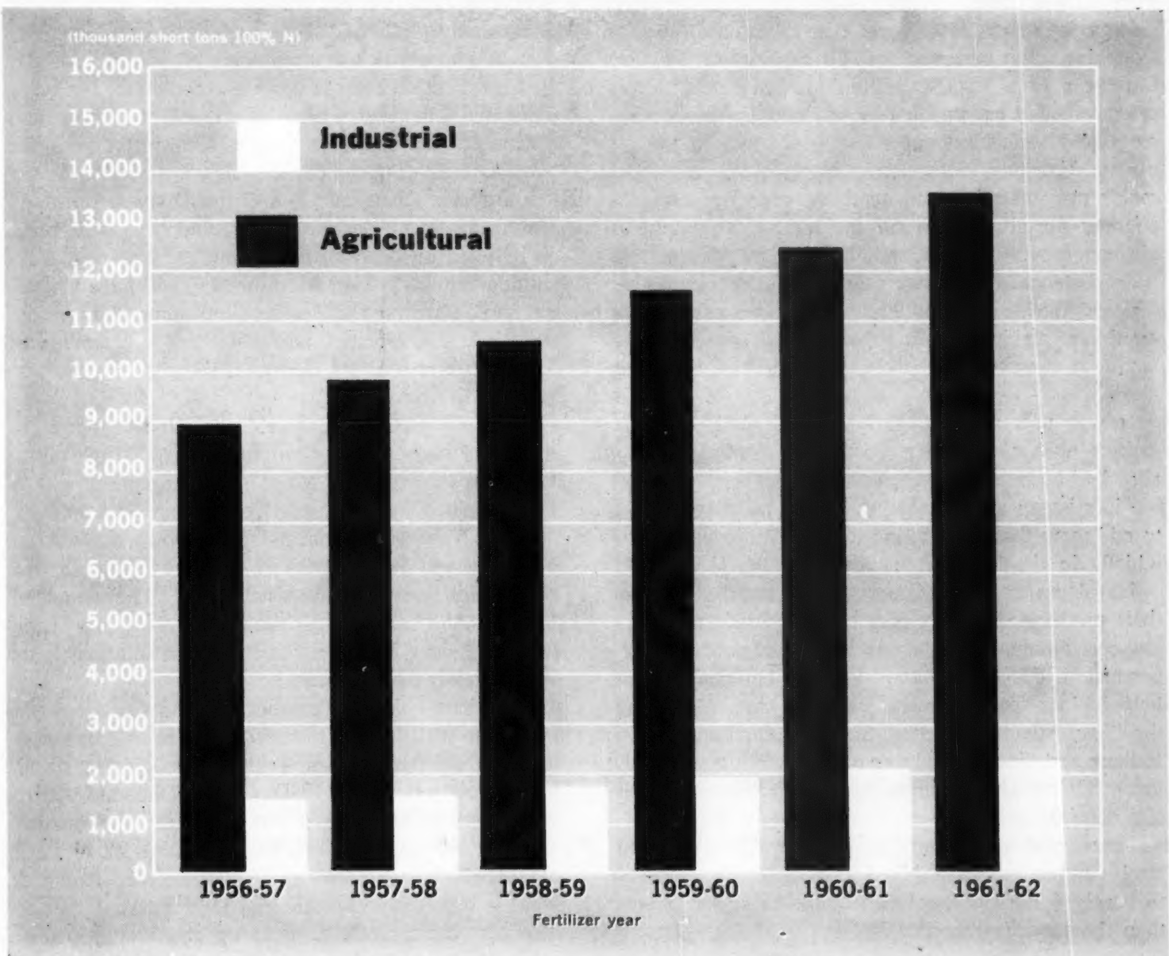
In the U.S.: Some nitrogen authorities believe that this step-up in use of in-place plant capability indicates, finally, the end of an era of capacity/supply imbalance that began, especially in the U.S., during the early '50s.

In commenting on the U.S. picture recently, for instance, John Riley, president of Southern Nitrogen (Savannah, Ga.), said that there is no doubt that the synthetic nitrogen industry has gone "completely through the phase of serious overcapacity." Riley added that "substantial new capacity must be built during the '60s if shortages are to be averted."

As if to bolster this contention, the industry plans

Agricultural fertilization: Outlet this year for about 13.5 million tons of nitrogen (see below).

Estimated World Nitrogen Production



to add more than a million tons to total U.S. synthetic anhydrous ammonia capacity alone over the next two years or so. New urea plants due in this year and next will lift U.S. potential for that important fertilizer and industrial product to nearly 1 million tons/year. That's about 200,000 tons more than was operating just a couple of years ago.

Increases, too, are slated in production and capacity for ammonium nitrate, nitric acid, ammonium phosphates, and other nitrogenous materials.

Explosive Growth: Growth of the synthetic nitrogen industry throughout the world has been phenomenal. U.S. growth, particularly, has been dramatic.

Until World War II, synthetic facilities were the lesser source of nitrogenous products in the U.S. Capacity in '40, for example, was some 380,000 tons and accounted for less than half the total nitrogen supply. Only seven companies, in nine plants, were then producing synthetic material, and the major raw material was coke.

America's entry into World War II set off an expansion binge that careened the '40 capacity of 380,000 tons/year to a level 1 million tons higher. All this unprecedented expansion was financed by the government and brought about startling changes in the industry. For one, natural gas displaced coke as the major raw material, and synthetic capacity soon accounted for about 80% of the total U.S. supply of nitrogen for fertilizer and industrial product production.

Importance of nitrogen as a military explosive lessened during the war because of advancements in munitions making, but it surged ahead as a fertilizer factor to contribute greatly to wartime food and fiber needs.

It was not until the early '50s, though, that the surplus nitrogen capacity created during the war was absorbed by peacetime applications.

Then began a trend that in only a half-decade was to add more than 1.5 million tons of synthetic nitrogen (chiefly in the form of ammonia) to the U.S. scene.

Petroleum companies, scouting means to upgrade their products, found it easy to switch into relatively low-cost ammonia production by utilizing refinery by-product hydrogen. Among the oil companies that helped pin a "petrochemical" label on ammonia during the '50s: Atlantic Refining, Sun Oil, Standard Oil of Indiana and Sinclair Refining (Calumet Nitrogen Products), Union Oil, Phillips Petroleum, Standard Oil (California).

These, and expansions by primary chemical and steel companies, have hiked U.S. nitrogen capacity to nearly 6 million tons/year, about 15 times greater than the capacity recorded in '40.

And expansions in nitrogenous products continue unabated. A raft of fertilizer projects in the U.S. are either planned, under way, or have recently been completed.

Construction has started at Armour Agricultural Chemical's six-plant nitrogen fertilizer complex at Cherokee (near Sheffield), Ala., part of a scheduled $60-million chemical fertilizer expansion program. The 360-tons/day ammonia and 50-tons/day urea plants will be built by M. W. Kellogg Co. Chemical Construction has the contract for a 500-tons/day ammonium phosphate installation, and Chemical and Industrial Engineering Corp. will put up Armour's 300-tons/day nitric acid, 250-tons/day ammonium nitrate and 250-tons/day nitrogen solutions plants.

A few weeks ago American Cyanamid disclosed plans for a $3-million anhydrous ammonia expansion at its Avondale (Fortier), La., plant. Capacity will be increased 40% (to about 75,000 tons/year), and ammonia storage facilities will be doubled. Work will be completed in late '62.

U.S. Phosphoric's first ammonia plant (350 tons/day at East Tampa, Fla.) is nearing completion. It's being built by Chemical Construction and features, says Chemico, "an ammonia synthesis converter with the largest single designed capacity in the world."

California Chemical Co.'s Ortho Division (formerly California Spray-Chemical) later this year will bring in its third nitrogen fertilizer complex. The new, $22-million spread, at Fort Madison, Ia., will have Chemical and Industrial Engineering-built ammonium nitrate and nitric acid facilities, and a 300-tons/day anhydrous ammonia unit built by Bechtel. Feedstock for the ammonia will be natural gas.

Farmer-owned Mississippi Chemical will double (to 400 tons/day) nitrogen fertilizer capacity at its Coastal Chemical's Pascagoula, Miss., plant. Expansion should be completed by early '63. Cost: about $4.5 million.

Solar Nitrogen Chemicals (jointly owned by Atlas Chemical and Standard Oil of Ohio) is laying out $15 million for a complex at Joplin, Mo. The estimated 300-tons/day anhydrous ammonia plant has been operating since May; urea and nitrogen solutions units will be ready by October.

And there's more. Shamrock Oil and Gas steps out next year with its first chemical venture, a 150-tons/-day ammonia plant now being built adjacent to its McKee oil refinery at Dumas, Tex. Diamond Alkali is expected to be in early next year with an estimated 70,000-tons/year ammonia plant at Deer Park, Tex.; output will be marketed by Monsanto. And Rohm & Haas is reportedly expanding at Deer Park.

W. R. Grace is now operating about 60,000 tons

of new ammonia capacity at its Nitrogen Products Division's Memphis plant. The new unit, which employs the methane-steam reforming process, brings the plant's over-all ammonia capacity to more than 160,000 tons/year. Much of this additional ammonia will replace outside sources supplying Grace's raw-material requirements for its 100,000-tons/year urea plant.

And Grace has also revealed plans to build a new, 60,000-tons/year ammonia plant at Big Spring, Tex., adjacent to the Cosden oil refinery in which Grace holds a 53% interest. The plant, constructed by Foster Wheeler Corp. and expected to be ready early in '62, will be operated by Cosden.

Tennessee Corp.'s new, 100,000-tons/year synthetic nitrogen plant at East Tampa will also be in operation early next year. Southern Nitrogen has a 15-year contract with Tennessee to buy 30,000 tons/year of the new production. The material boosts Southern Nitrogen's ammonia supply about 30%, is the basis for expanding nitrogen products facilities at the Tampa plant of the company's wholly owned subsidiary, Florida Nitrogen Co.

The expansion program, to be completed by early fall, doubles (to 40 tons/day) a urea crystallizing plant, adds a second, 100-tons/day, nitric acid unit, and doubles the Tampa plant's ammonium nitrate evaporating capacity.

Southern Nitrogen also plans to increase its Savannah, Ga., anhydrous ammonia capacity by '63 from 100,000 to 150,000 tons/year.

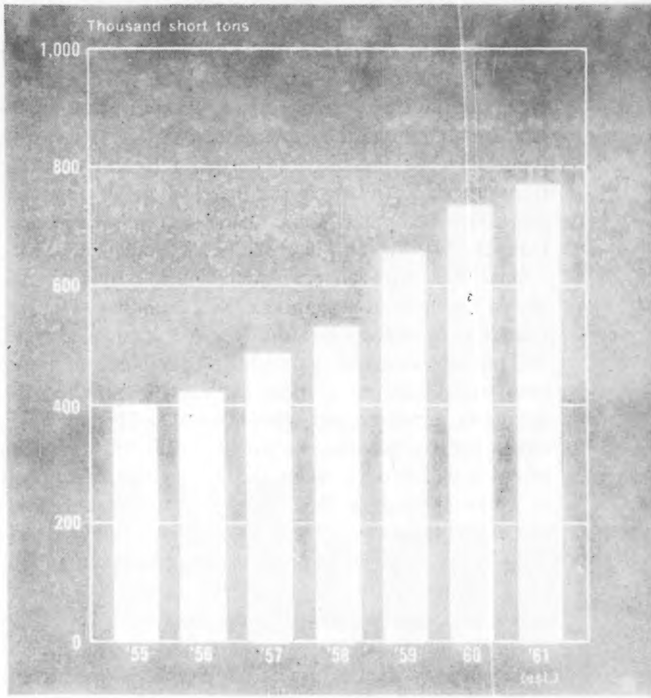
Among other major U.S. ammonia expansions in the works: a new, estimated $8-million fertilizer plant by Consumers Co-operative at Hastings, Neb.; a 50,000-tons/year Dow plant at Plaquemine, La.

Around the World: The mushrooming of nitrogen fertilizer facilities isn't confined to the U.S., of course. In Great Britain, for example, total synthetic nitrogen capacity is expected to top 775,000 tons N by '65, when new under-construction and projected installations are operating.

A 150,000-tons/year ammonia plant is now being built on a five-acre tract adjacent to Esso Petroleum Co. Ltd.'s Milford Haven (South Wales) refinery. The development, owned 50-50 with Fisons Ltd., will cost about $11.2 million, be completed in the spring of '64. Bulk of the Milford Haven output will be converted into nitrogen fertilizers at a nearby Fisons complex.

Within a year or so Fisons will also have completed a synthetic nitrogen expansion at Flixborough (in Lincolnshire). Rated capacity of the existing plant (jointly owned with West Norfolk Farmers) is about 13,000 tons N; this will be more than doubled. Chemical Con-

U.S. Urea Production



U.S. Ammonium Nitrate Production

(Thousand short tons)

Year	Fertilizer grades Solid	Solutions	Nonfertilizer (explosives, etc.)	Total
'55	1,137	705	241	2,083
'56	1,178	716	289	2,183
'57	1,556	783	247	2,586
'58	1,521	848	212	2,581
'59	1,525	1,110	223	2,858
'60 (est.)	1,550	1,200	290	3,040
'61 (est.)	1,560	1,250	300	3,110

Statistical Credit

Statistical data in this report, on which CW estimates were based, were derived from the following sources:

- U.S. Dept. of Commerce—Bureau of Census; Business and Defense Services Administration; Facts for Industry, annual reports.
- U.S. Dept. of Interior—Bureau of Mines; Mineral Facts and Problems; bulletins, other reports.
- U.S. Dept. of Agriculture—Agr. Research Service; Agr. Marketing Service; bulletins, other reports.
- The Organization for European Economic Cooperation
- The British Sulphur Corp., Ltd. publication Nitrogen, the Magazine of World Nitrogen.
- Food and Agricultural Organization of the United Nations.
- Private and industry sources.

struction (G.B.) has the contract to build the plant, which will use hydrocarbon gases from the nearby steel works at Scunthorpe.

These new ammonia and nitrogen projects will make Fisons one of the two largest nitrogen producers in the U.K., enable it to integrate its 400-tons/-day ammonium nitrate operation. At present the firm reportedly buys much of its needed ammonium sulfate from top U.K. nitrogen producer Imperial Chemical Industries Ltd., and some ammonia and nitric acid from the Shellhaven plant of Shell Chemical Co. Ltd.

And ICI, with an estimated 475,000 tons N ammonia capacity at five plants, isn't standing still. Recent reports indicate that the firm will spend nearly $5 million to modernize part of its Billingham complex now using coke as a basis for making nitrogen for ammonia, fertilizer and other products. The division's coke ovens, which use an estimated 600,000 tons/year of coke, will be shut down and the operation switched to a new Billingham Division process for making low-cost hydrogen via light oil. In addition, ICI is building a new, 100,000-tons/year anhydrous ammonia plant at Severnside.

All told, annual synthetic ammonia capacity in the U.K., including an expansion adding nearly 10,000 tons/year to Shell's original 75,000-tons/year plant at Shellhaven, is close to 560,000 tons N. As indicated above, this capacity is slated to grow well over 215,000 tons by early '65.

Production of U.K. nitrogen (fertilizer and industrial) has been rising fairly consistently over the past few years. During the fertilizer year '56-'57 output totaled approximately 500,000 short tons. Over the two succeeding years production increased about 13,-000 and 11,000 tons, respectively, and in '59-'60 hit an estimated 585,000. While complete data isn't yet available on '60-'61 performance, indications are that production climbed to about 675,000 short tons. Industrial nitrogen production, also rising, may have reached 160,000 tons in the crop year just ended.

West Germany Soars: Expansion of the West German nitrogen industry in recent years has been remarkable—and perhaps one more irritation to the Soviet-dominated East German regime. Output in '48 hit scarcely 250,000 metric tons; by '58-'59 production had soared fivefold, to more than 1 million tons N. Rate of growth has eased a little since then, but total fertilizer output (chiefly coke-oven ammonium sulfate, ammonium nitrates, and urea), on a nitrogen content basis, climbed to about 1.1 million tons during '59-'60. In '60-'61 production was an estimated 1.15 million, and will likely grow to 1.25 million tons annually within a year or two.

Along with growth in production, West Germany has rapidly moved to a top spot among the world's nitrogenous fertilizer exporters. From practically zero in '48, exports shot up to nearly 400,000 tons N in '59.

Despite the growth of world production capacity—especially in countries once counted as fertilizer customers—and intensifying competition, particularly from Japan for Asian markets, West German exports in the current calendar year may yet reach some 600,000 tons N.

In terms of tonnage of fertilizer materials, West Germany exported about 830,000 tons of ammonium sulfate in '59-'60, the year Japan's exports for the first time exceeded 1 million tons. In comparison, the other leading exporters of ammonium sulfate in the last fertilizer year were Belgium, 752,000 tons; Italy, 663,000; Netherlands, 306,000. U.S. exports then were only 220,000 tons, topped slightly by the United Kingdom's 238,000.

In the year under discussion, however, West Germany increased its share of the world ammonium nitrate market from 26% to 40%. This worked out to about 280,000 tons N in '59-'60 vs. 153,000 the previous year.

Nitrogen expansions have slowed somewhat in West Germany, but the Chemiewerk Ruhröl Essen plant expansion (to 100,000 tons/year N) was recently completed. By-product ammonium sulfate from caprolactam production is expected to double by '62 or '63 if the reported caprolactam expansions by Badische Anilin- & Soda-Fabrik (from 35,000 to 50,000 tons/-year) and by Farbenfabriken Bayer are carried out.

French Growth: In France, nitrogen expansions in the works are expected to boost the country's capacity to nearly 1.5 million tons/year N by '63, much sooner than France's planned programs indicate.

In its recent review of the growth of the French nitrogen industry, *Nitrogen (Issue 10, March '61)* reported that under that country's current Five-Year Plan—its second, due to end in June '62—ammonia capacity was slated to increase more than 60%, to 970,000 tons N. Capacity expansion to about 1.4 million tons/year was not foreseen until the third Five-Year Plan (covering the period to '66) was implemented.

Already French nitrogen production is well on its way to an 880,000-tons/year rate, and new projects under construction and in advanced planning total about 400,000 tons N.

Current rate of nitrogenous fertilizer production is estimated at about 700,000 tons of material. During the crop year '57-'58 output as reported to the United Nations' FAO came to slightly over 500,000 tons N.

In '58-'59 this climbed to nearly 560,000, and in '59-'60, to about 600,000 tons N. Output next year is expected to climb 20-25% over '60-'61, exceed 850,000 tons N.

Production and use of industrial nitrogen is still relatively small in France and in other countries, compared with the U.S. use of about 950,000 tons/year, but it is growing satisfactorily. French production a couple of years ago just topped 50,000 tons, is expected to double during the current year.

Big feature in the French nitrogen industry growth—as in a number of European countries—is the waxing importance of natural gas as the hydrogen raw-material source. Development of oil refining and recent tapping of indigenous natural gas supplies, including exploitation of the large natural sour gas deposits at Lacq in southwest France, is proving this source of hydrogen more economic than coke-oven gas. While most French ammonia is still based on the latter, especially in the North, many upcoming expansions are tied in with petrochemical operations based on natural or oil-refinery gases.

Among the major expansions reported:

• At the Toulouse works of Office National Industriel de l'Azote (ONIA)—a government organization and largest among France's 14 producers of synthetic nitrogen—present 100-tons/day urea capacity will be increased to 300 tons/day. Installation of additional ammonium sulfate facilities to increase present capacity of 400 tons/day is also being considered. ONIA utilizes two ammonia synthesis methods, the Haber-Bosch process and the Fauser-Montecatini process, both based on natural gas.

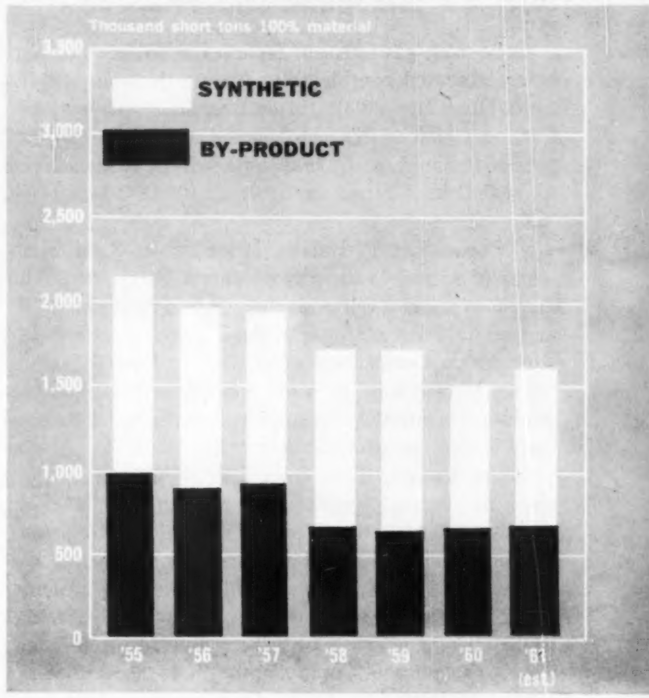
• A new ammonia plant with 240-tons/day N capacity will be completed this year by the Société des Produits Chimiques d'Aquitaine. Output is based on Lacq natural gas and will go to Azolacq for processing into fertilizers. (Azolacq is owned 50% by ONIA, 40% by Société Generale d'Engrais et des Produits Chimiques, Pierrefitte, and 10% by Banque de Paris et des Pays-Bas.) Azolacq will increase its 22,000-tons/year urea and its 44,000-tons/year (N) ammonium nitrate capacities.

• A huge nitrogen fertilizer works is planned at Donges by Société Chimiques de la Grand Paroisse using hydrogen from the nearby Antar des Petroles refinery and Lacq gas.

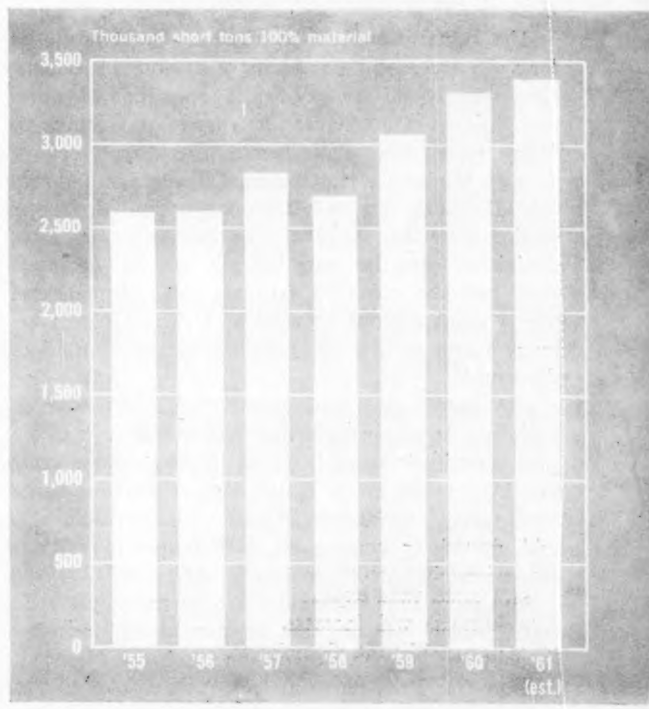
Capacity will be 200-225,000 tons/year of fertilizer materials. In the first phase, plants will be built to produce ammonia, nitric acid and ammonium nitrates.

• Pierrefitte is expanding nitrogen production at Soulom, where annual capacity has been upped from 37,000 tons N to about 64,000 tons. Output is based

U.S. Ammonium Sulfate Production



U.S. Nitric Acid Production



on natural gas (Fauser-Montecatini process) and is chiefly calcium nitrate, nitric acid and technical nitrogen.

Coke-oven gas nitrogen facilities in France are also being increased considerably. Among the more significant: Houillères du Bassin de Lorraine, with works at Carling. Capacity this year is being expanded to 84,000 tons N (from about 65,000 tons), will be further hiked to 93,000 in '62, and probably to 109,000 tons N by '63.

- Capacity at the Harnes (in the Pas-de-Calais area) works of Société Courrières-Kuhlmann is expected to be increased about 7,000 tons this year, to 52,000 tons N, and at La Bassee, Douvrin, Société Industrielle et Financiere de Lens capacity, based on coke-oven gas, is up to 77,000 tons N from a previous 60,000 tons. Ammonium nitrates are produced there and the company is also one of France's urea suppliers.

Japan Pushes: Few countries among the world's nitrogen fertilizer producers have pushed ahead as rapidly as has Japan. Output of major nitrogenous products in just the past five years, for instance, has increased more than 50%. Total production (in metric tons of nitrogen) was at the 661,000 mark in '55-'56; in the current fertilizer year it's estimated it will come close to 1 million. Ammonium sulfate production in '60-'61 amounted to about 2.5 million tons of product; and urea, continuing a remarkable climb, may have hit close to 650,000 tons.

The spectacular growth in Japanese nitrogen facilities long ago exceeded the capacity of its domestic outlets. Consequently, the country began penetration of southeast Asia as a market for its surplus production. A recent report from the Chemical Fertilizer Dept. of Japan's Ministry of International Trade and Industry (MITI) reveals that in '60 ammonium sulfate exports totaled more than 881,000 tons. Sulfate exports have diminished over the years but still account for more than half the country's fertilizer sales abroad, and this is keeping Japan up with the U.S. and West Germany among the top nitrogenous fertilizer exporters in the world.

Urea production and exports have increased so rapidly in Japan since '55 that observers believe all the urea capacity installed in Japan in the past few years was built primarily to exploit foreign markets. Some 30% (over 150,000 tons) of last year's production was sold abroad. In comparison, U.S. output in '60 was approximately 735,000 tons (*see table, p. 37*).

And more urea expansions are on the way. Japan Gas-Chemical will increase its present 180-tons/day capacity to 270 tons. Completion is scheduled for '62. Nippon Gas K.K. plans to hike its urea capacity to 150 tons/day, and urea reportedly will be produced at Kyowa Fermentation's Nakajo plant.

The Niigata plant of Toyo Gas Chemical will soon have a new, natural gas-based, 100-tons/day ammonia plant, and doubled (from 30,000 tons/year) urea capacity. The present gasification furnace at Nippon Suiso's Onahama plant will be replaced with a new type of furnace utilizing crude oil; and ammonium sulfate production will be cut back to make possible a new, 60,000-tons/year urea plant and a 50,000-tons/-year high-analysis fertilizer plant.

Italian Climb: Production of nitrogenous fertilizers in Italy continues to show vigorous growth. Two chief reasons: increasing markets for exports; discoveries of abundant natural gas as a source of hydrogen for fertilizer production.

There is little doubt that total nitrogen fertilizer output in '61-'62—with ammonium sulfate maintaining the lead—will match the 10% gain registered in '60-'61 over the previous fertilizer year. This would indicate production of well over 700,000 metric tons N, with ammonium sulfate climbing to perhaps 275,000 tons.

Prior to World War II, Italy's nitrogen fertilizer shipments abroad were virtually all in the form of ammonium sulfate, but this compound now accounts for considerably less than half the exports; Italian production of ammonium nitrates and urea has grown substantially over the years.

Nonetheless, sulfate exports last year, in terms of product, were about 610,000 metric tons. In '56, they were less than 275,000. Ammonium nitrate exports hit a peak in '59—approximately 430,000 tons—but dropped slightly last year.

Italy's largest customers are countries in the Near East and in Africa, but close neighbors (including Austria, Yugoslavia and Bulgaria) are becoming important buyers. Nitrogen fertilizer exports have risen from about $24 million in '55 to $55 million in '60. Prospects are for a further gain this year.

There are four leading fertilizer producers in Italy, and all have expanded, or are considering new nitrogen expansions. ANIC, a chemical member of the government oil and gas monopoly, Ente Nazionale Idrocarburi (ENI), currently produces some 1 million tons of fertilizer annually at its Ravenna plant near the Adriatic.

Sincat (Edison group) is a relative newcomer to the fertilizer field, but output from three plants totals nearly 700,000 tons/year of nitrogen. The Porto Marghera plant turns out nitrogen fertilizers and calcium cyanamide; the Priolo (Sicily) and Vado Ligure plants compound fertilizers.

Montecatini operates about 40 plants and reportedly produced 1.2 million tons of fertilizers last year. Fauser-

Montecatini patents are in use in about 300 plants throughout the world. The sprawling company at present turns out urea (45-46% nitrogen) and is a major factor in such Italian production.

Rumianca is heavily concentrated in compound fertilizers. It has its own patented process which is licensed in many countries. All Rumianca fertilizers are granular and all contain nitrogen in ammonia form.

Red Nitrogen: Statistics and information concerning the nitrogen industries of the U.S.S.R. and satellite countries in Eastern Europe are generally suspect. But if indications from inside and outside the Soviet Bloc are fulfilled, growth has been—and will continue to be—impressive.

East German production of approximately 380,000 metric tons of nitrogen in '59-'60 reportedly met that country's production plans. Poland is planning to up its nitrogen fertilizer capacity by '65 to nearly 184% of its estimated '59 output. Last year production of nitrogenous fertilizers in Hungary was said to have reached close to 260,000 tons of product, and included in a recent progress report on expansion plans was word that the long-delayed 100,000-tons/year fertilizer plant at Tiszapalkonya would be in operation this year. The plant will use natural gas piped from Rumania.

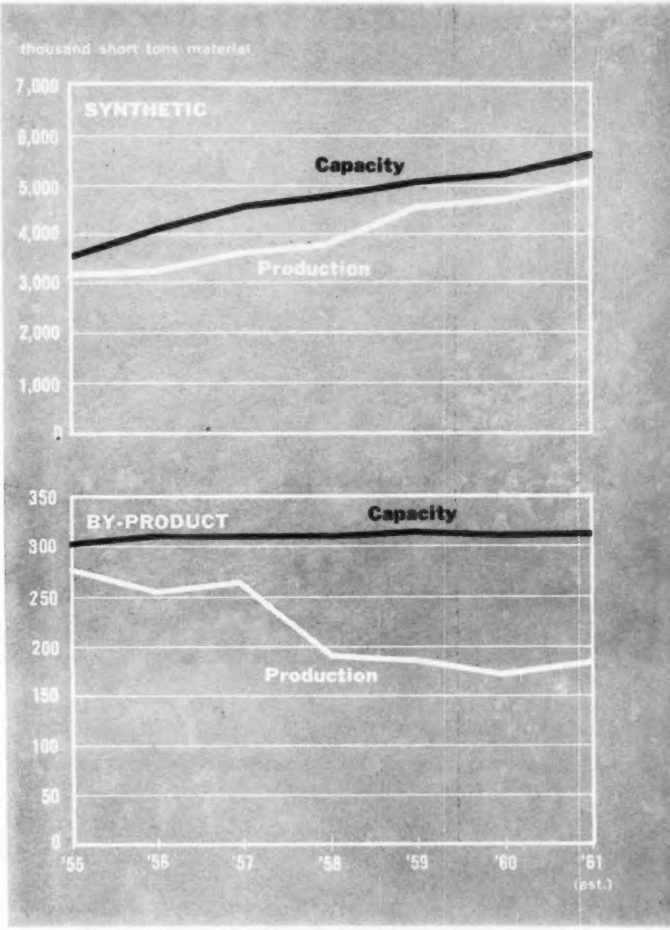
It would appear from the reported expansions and plans in the works that Hungary may become a net exporter of nitrogen fertilizers.

The magazine *Nitrogen* also reports that the Rumanian nitrogen fertilizer industry at the end of '60 was in a phase of rapid expansion, and that fertilizer output in '61 would increase to about 450,000 tons N. Due to come onstream this year is the Roznov Works, with an annual capacity of 100,000 tons of ammonia, 10,000 tons of urea and about 210,000 tons of other nitrogenous fertilizers.

In Bulgaria nitrogen fertilizer production, solely from that country's Dimitrovgrad Works, was said to have been 67% higher in first-quarter '60 than in the comparable '59 period. A projected plant at Stara Zagora is pegged to turn out some 300,000 tons/year of ammonium nitrates by '63, and facilities to produce 500,000 tons/year of ammonium sulfate and about 20,000 tons/year of urea are planned for '66.

In the U.S.S.R. itself, the increased production of nitrogen products has been an integral part of that country's various plans and has shown up in its efforts to acquire plants and equipment from the West. One Belgian firm reportedly will provide know-how for two ammonia synthesis units, and another will supply equipment. Three urea plants are to be built by a Dutch company. In addition, the Soviet Union is building a liquid fertilizers complex near Tula that should be in

U.S. Anhydrous Ammonia: Production vs. Capacity



U.S. Imports: Major Nitrogenous Materials

Material	'55	'56	'57	'58	'59	'60	'61 (est.)
	thousand short tons						
Ammonium nitrate mixtures	405	437	353	335	341	246	198
Ammonium phosphates	235	191	169	159	216	118	170
Ammonium sulfate	173	198	165	187	218	211	203
Calcium cyanamide	82	67	58	57	58	44	45
Calcium nitrate	56	65	60	88	69	62	64
Potassium-sodium nitrate	19	19	25	24	36	16	20
Sodium nitrate†	608	500	585	446	462	333	210
Urea	79	70	59	49	64	82	93
Other	7	9	9	12	22	41	45

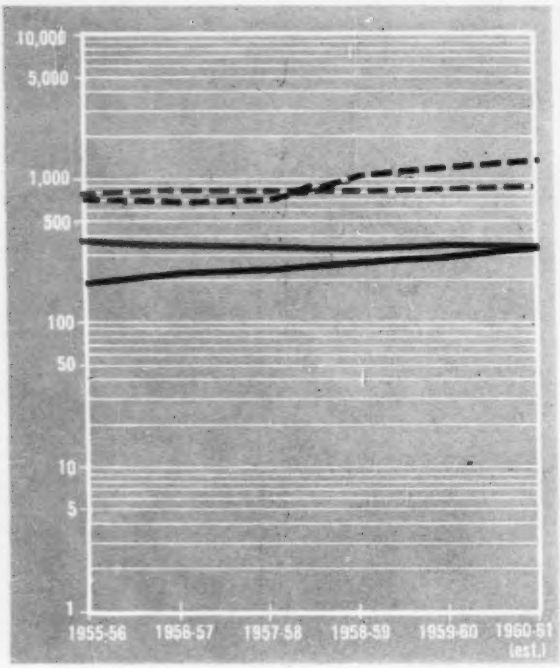
*Chiefly from Canada. **Chiefly from Norway and West Germany. †Chiefly from Chile.

N SPECIAL REPORT

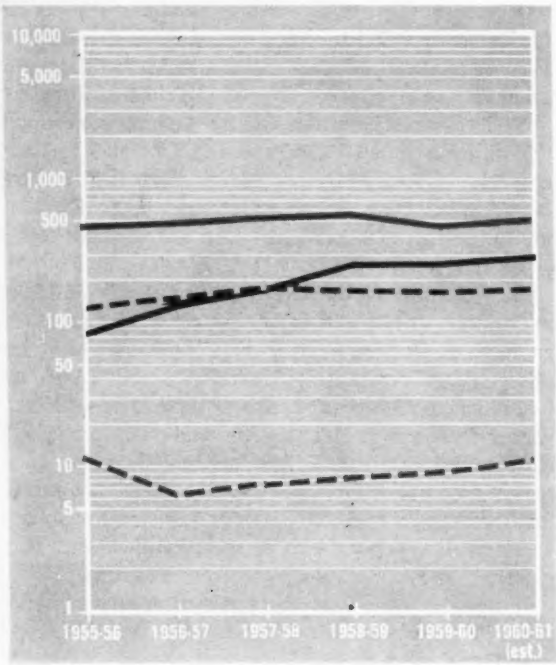
Fertilizer Production in Major Exporting Countries

Thousand metric tons N

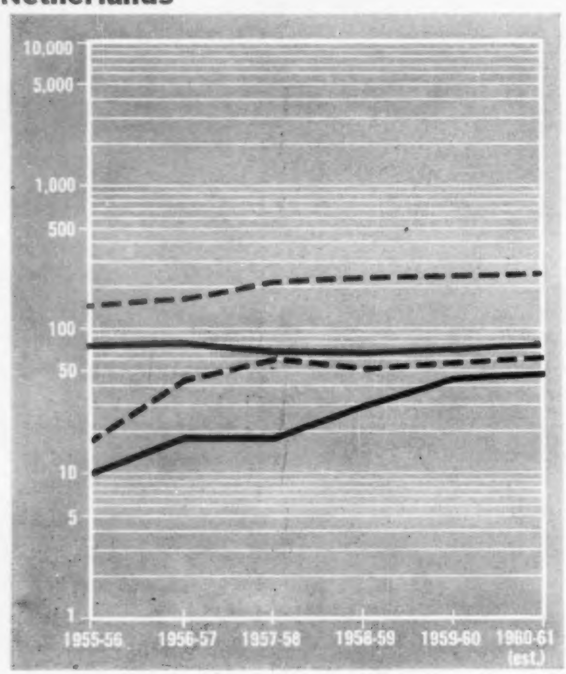
United States



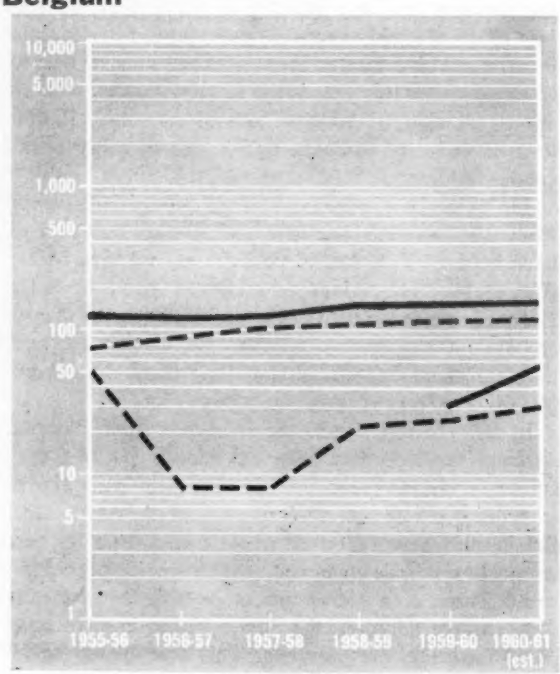
Japan

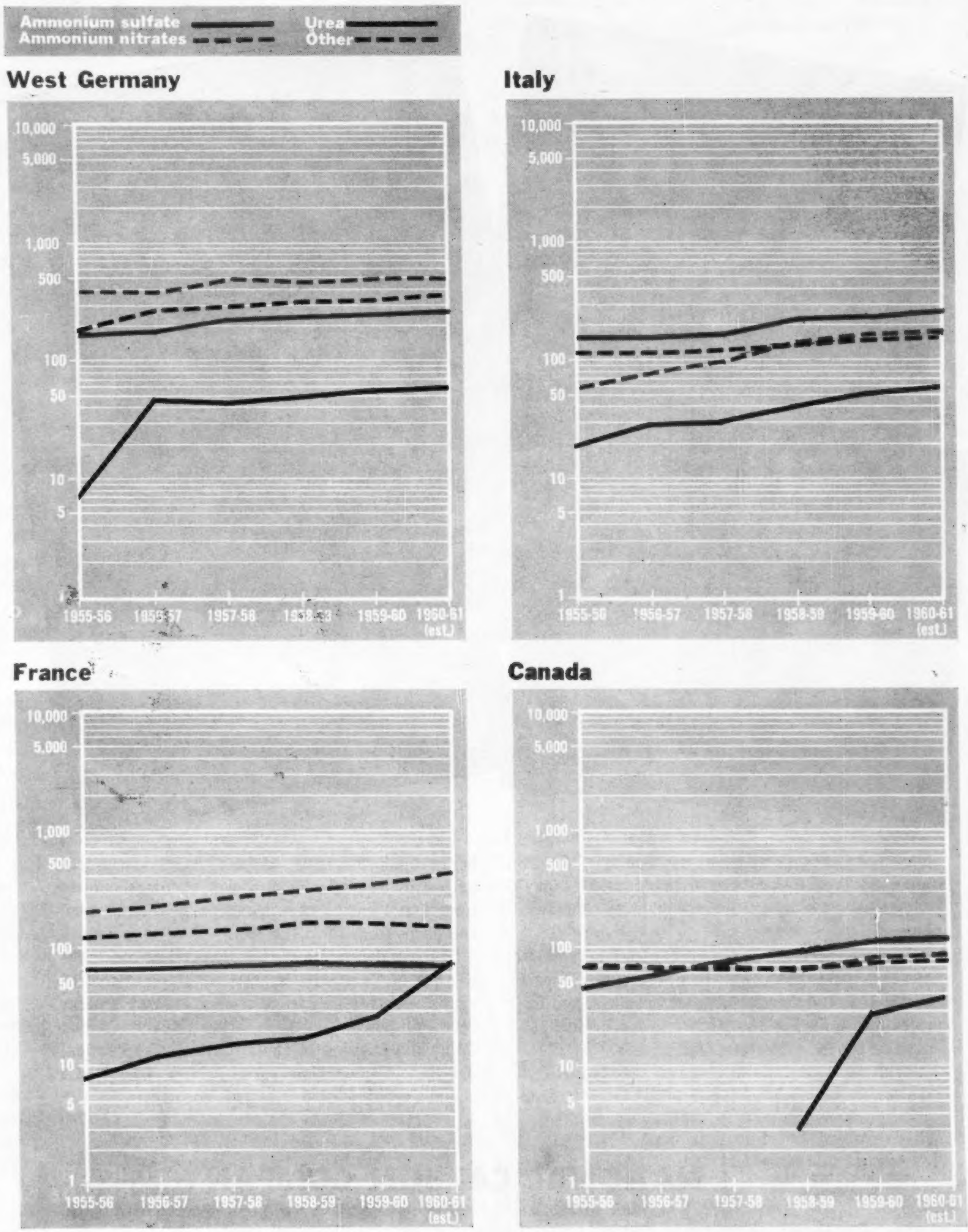


Netherlands



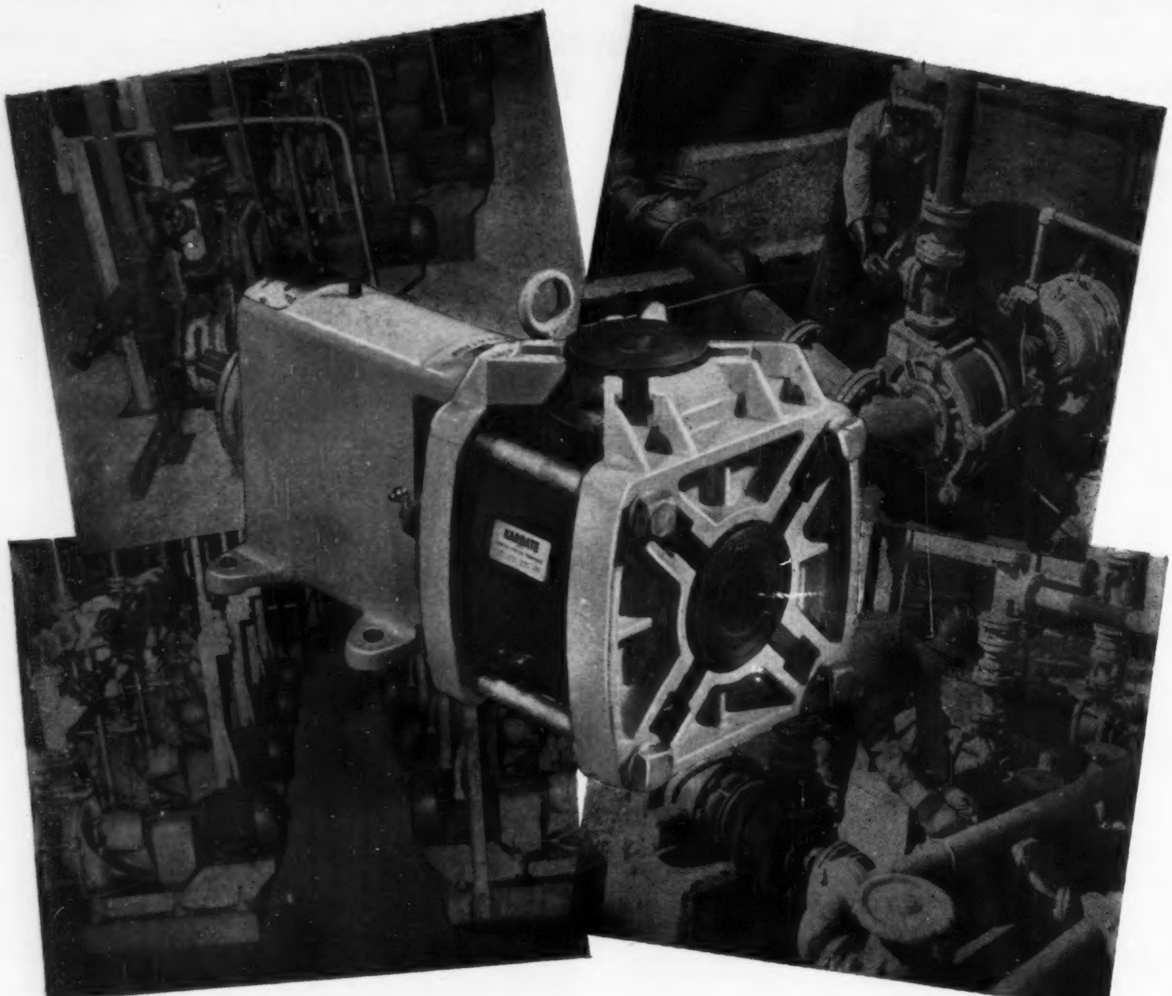
Belgium





Ammonium sulfate
Ammonium nitrates
Urea
Other
West Germany
Italy
France
Canada
10,000
5,000
1,000
500
100
50
10
5
1
1955-56
1956-57
1957-58
1958-59
1959-60
1960-61 (est.)

NEW FRAME-MOUNTED MODELS EXPAND "KARBATE" PUMP LINE!



National Carbon's addition of "Karbate" frame-mounted Type F pumps to its line provides today's widest selection of impervious graphite centrifugal pumps!

Designed and built by the world's leading producer of non-metallic centrifugal pumps, the new Type F has 1, 1½, and 2-inch discharge openings, and features the same wet end parts and mechanical seal used on proved motor-mounted models.

With capacities to 140 gpm and heads to 67 feet, the new frame-mounted Type F brings to 32 the number of standard sizes of "Karbate" impervious graphite pumps . . . offering discharge openings ranging from 1 to 4 inches, capacities from 5 to 1500 gpm, and heads from 15 to 120 feet.

You can depend on the unsurpassed corrosion resistance of "Karbate" impervious graphite centrifugal pumps for all corrosive pumping service. For details on models and sizes, write: National Carbon Company, Division of Union Carbide Corporation, 270 Park Avenue, New York 17, N. Y. *In Canada:* Union Carbide Canada Limited, Toronto.

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UNION CARBIDE

operation next year. Principal product will be liquid ammonia.

Other expansion projects include a tripling of nitrogen capacity at the Gorlovka works. Nitrogen fertilizer production started just this year at the Chirchik electrochemical works, which is among the new facilities to use natural gas.

And recently the Soviet Union concluded a trade agreement with Italy under which it would get several plants, including a couple to produce ammonia.

Elsewhere in the World: India, like many major fertilizer-buying countries, is moving fast in establishing a thriving nitrogen industry. Imports of nitrogenous fertilizers, still at a high level—an estimated 110,000 tons N in '60-'61—may soon dwindle. The government plans to build a nitrogen fertilizer plant in each state, has several projects under way.

Recently a state-owned fertilizer corporation signed a 10-year agreement with a major oil refinery to supply 50,000 tons/year of refinery gas for production of 350,000 tons of fertilizer, equivalent to 90,000 tons of nitrogen and 40,000 tons of phosphate. Estimated capital outlay for the project: $52.2 million.

A new 80,000-tons N plant came onstream late last year at Nangal with initial production of some 200 tons/day of lime ammonium nitrate; a 70,000-tons N urea plant is expected in this year or early next at Neyveli, Madras. Ammonia plans include a 120,000-tons N unit for Rourkela, Orissa, and a 90,000-tons/year N plant at Trombay, near petroleum refineries.

India has also granted a license for a 350,000-tons/-year fertilizer complex (200,000-tons ammonium phosphate and 150,000-tons ammonium sulfate units) to Parry & Co. (largest private fertilizer company in the country), International Minerals & Chemical, and California Chemical (*CW Business Newsletter, March 4*). Proposed site: Vizagapatam, Andhra.

In the Middle East, Iraq's first chemical fertilizer plant should be in operation by '65. The complex, at Abi Flus, Basrah, will produce 116,000 tons/year of ammonium sulfate, 56,000 tons of ammonium nitrate, 20,000 tons/year of sulfuric acid. The Egyptian Chemical Industries' calcium ammonium nitrate plant at Aswan has just been expanded from 1,200 to 1,600 tons/day, and the country is contemplating a new ammonium sulfate project. Lebanon is said to be mulling over plans for an ammonia unit near one of the country's two oil refineries.

Among nitrogen developments in this hemisphere: Mexico has plans for a $2.5-million fertilizer complex on the Isthmus of Tehuantepec. The plant, to be operated by Fertilizantes del Istmos, will turn out urea, ammonium nitrate, ammonium sulfate and ammonium phosphates, among other nitrogenous materials.

By '64 Peru will have a $15.5-million, 190-tons/day ammonium nitrate fertilizer plant at Cuzo, in the south. Three German firms—Uhde, Ferrostaal and Hochtief—got the order recently.

Canadian Developments: Although Canada is strongly agricultural, it produces about half of its fertilizers for export. This runs to about $50 million/-year, with about 90% going to the U.S.

Plants, for the most part large-scale, operate on a relatively inexpensive nitrogen source (Alberta natural gas) or function as auxiliaries to other operations, such as Cominco's smelter at Trail, and Sherritt Gordon's at Ft. Saskatchewan. Fertilizer producing points—east and west—have access to the big U.S. market on a duty-free basis, and in some instances are actually closer to these markets than competitive U.S. plants.

Factors that help Canada's fertilizer industry include softening of the Canadian dollar—prices are usually quoted in U.S. money; general increase in fertilizer demand in Latin America and the Far East; the trend toward use of higher-analysis fertilizers (urea, for example); and lowering transportation charges.

Some additional recent developments in the nitrogen fertilizer segment of Canada's industry include completion, earlier this year, of Cominco's urea plant at Calgary; start on construction of a urea plant by Sherritt Gordon at Saskatchewan; and possible entry into ammonium chloride by Rocky Mountain Chemical (*CW Market Newsletter, Aug. 5*).

Brockville Chemicals this summer completed a $20-million nitrogen plant at Maitland. There are reports that Borden Chemical is contemplating a fertilizer plant based on ammonium sulfate at Winnipeg, and Electric Reduction may get into diammonium phosphate at its Varennes, Que., complex.

Too Much Building? The worldwide hustle to construct new nitrogen fertilizer capacity would seem to indicate a singular lack of foresight on the part of nitrogen planners. There is no accurate tally of all the new agricultural nitrogen facilities that will be in operation within the next half-decade, but on the basis of a studied projection, world capacity by '65 could conceivably total 27-30 million tons N.

Consumption isn't likely to exceed a moderate 5-6%/year growth over the next five years, indicating a total of some 20 million tons N by '65. In sight, then, is another period of large excess capacity.

With the switch of many countries from importation to self-sufficient production, world trade in fertilizers will likely fall off, resulting in depressed operating rates. This prognosis is especially painful to major exporting areas such as North America, Europe and Japan.

Reprints of this report will be available for $1 each. Bulk rate on request.

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ACTION DESIRED:	Consider them for synthesis, purification, for your research projects		

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Oxidation — reduction.

Hydroxylamine salts are well-known reducing agents for metal ions such as ferric, cupric, and silver, and also for non-metallics such as organic peroxides and certain dyes. Because of this property, these salts have found industrial applications in dyeing, purification, and refining processes. The salts are very stable in acidic media, a property not possessed by many reducing agents.

Less well known, however, is the action of hydroxylamine as an oxidizing agent. This property has received little study, but it warrants your further investigation —particularly where oxidizing agents now used are not fully satisfactory.

For dyeing synthetic fibers.

Hydroxylamine sulphate is an ideal reducing agent in the cuprous ion method for dyeing synthetic fibers. One step in the process is the reduction of the cupric ion to the cuprous form, and hydroxylamine sulfate is reported to act as a reservoir for the cuprous ion as it is formed, thus avoiding precipitation of metallic copper which would result in dull colors. (It has also been reported that hydroxylamine acts directly on the fibers and makes them more easily dyed by direct wool dyes. It is possible that this process will soon displace the cuprous ion method when it has been more thoroughly evaluated.)

Shortstopper for synthetic rubbers.

The sulfate and chloride salts of hydroxylamine are used as non-discoloring shortstoppers in the production of butadiene-styrene rubber, GR-N-type synthetic rubber, and other polymers. In this use the hydroxylamine is added to inhibit further polymerization when the reaction has reached the desired conversion. The result, when hydroxylamine is used, is rubber with better color.

And reports from users indicate that CSC hydroxylamine salts have been, and are now being used, with *both* hot and cold polymerizations. What's more, their use is *not* confined to specialty rubbers, but they are also being used successfully with all-purpose synthetic rubber of the styrene-butadiene type.

The principal reason behind the increased use of hydroxylamine is the better color it produces in rubbers as compared with hydroquinone-stopped synthetics.

For synthesis.

The hydroxylamines are valuable for chemical synthesis of oximes, hydroxamic acids, and numerous intermediates—also for preparation of anti-skinning agents,

Physical Properties	HYDROXYLAMMONIUM ACID SULFATE	HYDROXYLAMMONIUM SULFATE	HYDROXYLAMMONIUM CHLORIDE
Formula	$NH_2OH \cdot H_2SO_4$	$(NH_2OH)_2 \cdot H_2SO_4$	$NH_2OH \cdot HCl$
Molecular Weight	131.11	164.14	69.50
Melting Point, °C	Indefinite	177*	152*
pH of 0.1M Aqueous Solution at 25°C	1.6	3.7	3.4
Solubility at 25°C, g/100 g solvent			
In Water	Approx. 390	63.9	94.7
In 95% Ethanol	4.3	0.2	10.5
In Methanol	20.2	0.1	17.5

*Melts with decomposition.

anti-rusting agents, and pharmaceuticals. For example, hydroxylamine reacts readily with aldehydes and ketones to give high yields of oximes which are useful in a variety of applications, including the preparation of antioxidants and stabilizers. When added to inks and paint, oximes are useful as anti-skinning agents.

Effects on proteins and biological systems.

Hydroxylamines inhibit certain enzymes, such as catalase. Gelatin treated with hydroxylamine shows considerable resistance to acid etching. It also inhibits bacterial growth, and many of its derivatives have fungicidal properties. And hydroxamic acid, prepared from hydroxylamine, possesses interesting pharmacological activity.

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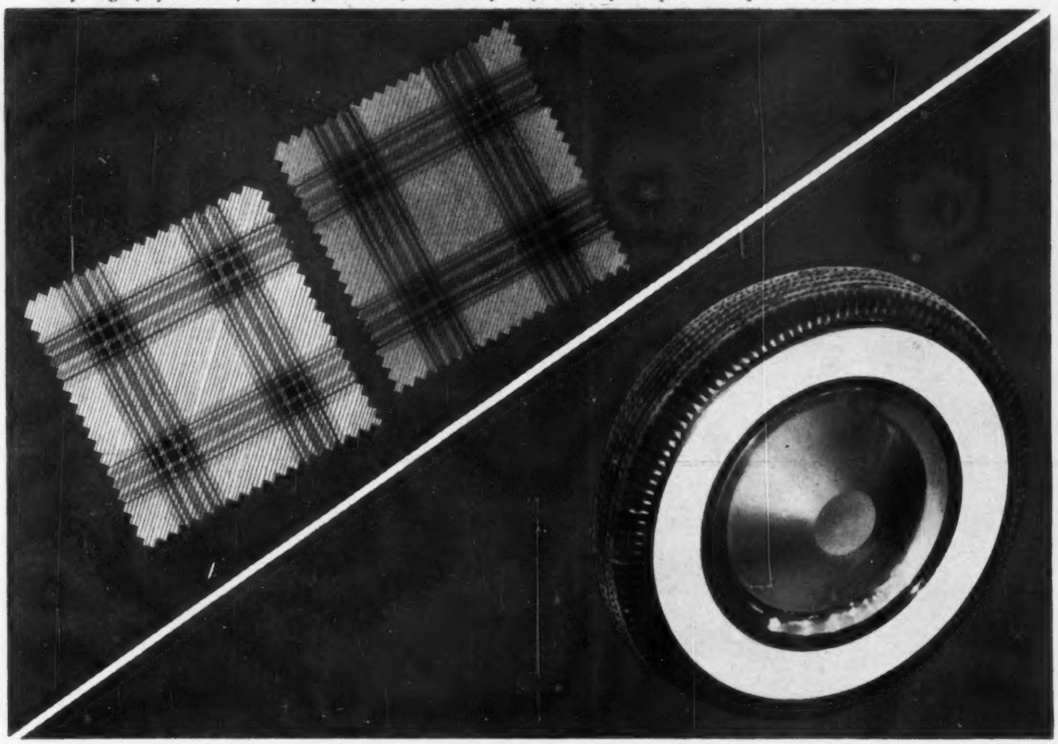
HYDROXYLAMINES

There is a difference in color when synthetic fiber (on left) is treated with hydroxylamine during dyeing. Dyeing of synthetic fibers is just one of the many ways that hydroxylamines prove useful to industry.



Another of the many uses of hydroxylamine salts is in rubber production to achieve brighter, clearer color.

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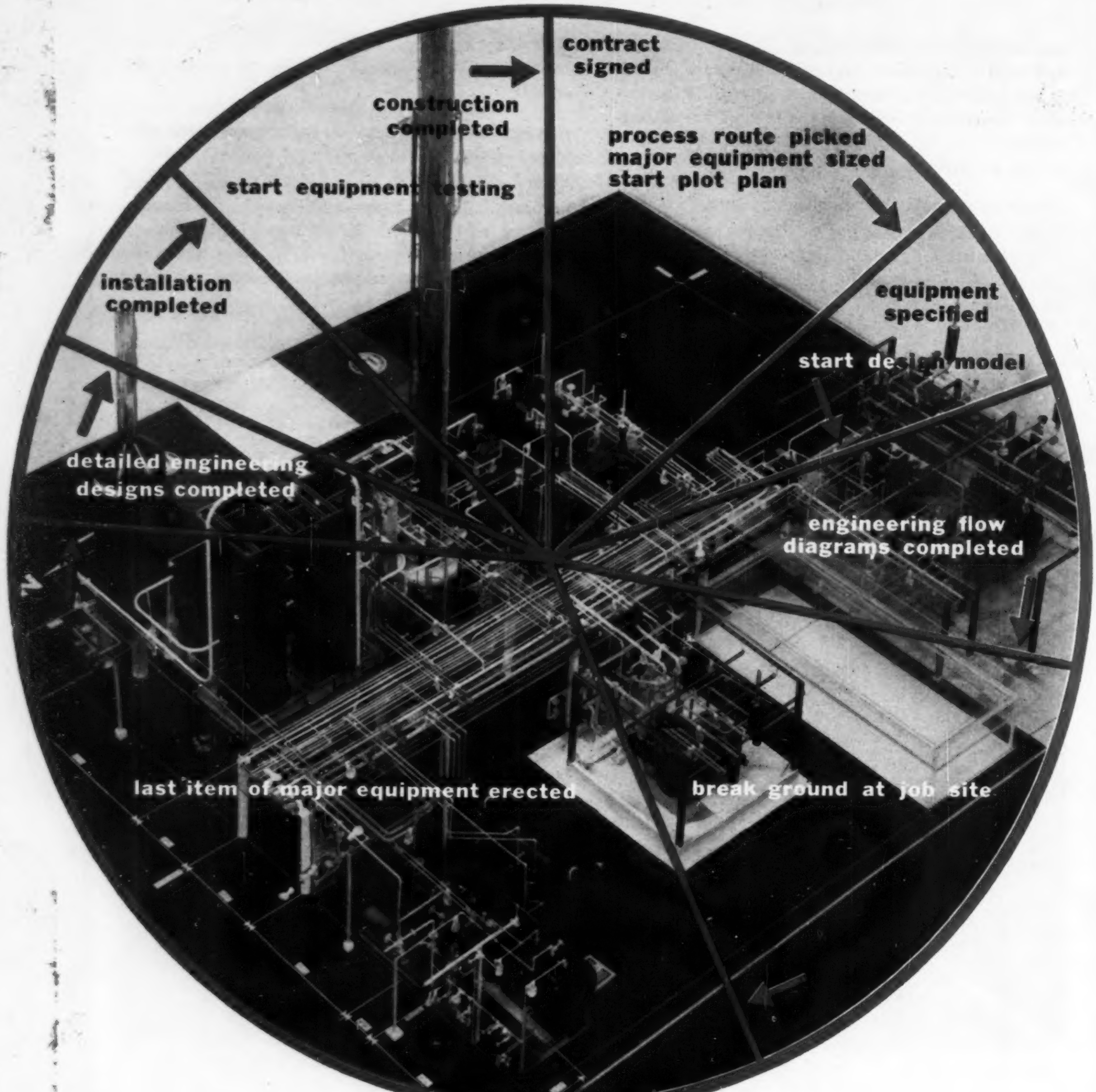
Controlling the clock in design and construction



Faster-Phased Plan Speeds Plant Building

The first Detol unit for hydrodealkylating petroleum aromatics to benzene is now fully onstream at Houston, Tex. Built for Crown Central Petroleum Corp. by Catalytic Construction Co. (Philadelphia), the plant was designed and constructed in just five and a half months from the date of contract signing.

This strikingly short schedule echoes widespread reports that chemical process plants are now being built faster than in any period in the industry's history (except during the crash programs of World War II). Consensus of engineering contractors indicates that today's plants are built 21-27% faster than they were three or four years ago.

And not only are plants being built faster, scheduling times for various phases of construction also differ from project schedules of a few years ago. Reason: improvements in engineering design and construction methods stemming from (1) more frequent use of models and (2) the control offered by critical-path scheduling (*CW, Oct. 15, '60, p. 74*).

The chart *(above)* reveals the schedule for each phase of design and construction of Crown Central's plant. The same control points can be related to other CPI projects because the quota of equipment in a Detol unit—which includes reactors, distil-

lation towers, furnaces, compressors —would likely be similar to that of most process plants.

The timing, based on the Crown Central project:

- Initial 13-14% of the schedule: process flow diagrams should be completed, major equipment (towers, tanks, reactors, compressors, etc.) should be sized and the plot plan started.
- After 19-20%: the mechanical design and specifications of the major equipment should be completed for purchasing and the design model started.
- After 27-28%: the engineering flow diagrams, showing all instrumentation, all valving, utility lines and all pipe sizes should be completed.
- After 43-44%: the construction crews should have broken ground at the plant site.
- After 75-76%: all major equipment should be delivered to the site and erected on foundations.
- After 81-82%: all detailed engineering (piping isometric drawings, electrical conduit layout, instrument lines, etc.) should be completed.
- After 87-88%: the installation should be complete.
- Remainder of time, until all construction is declared completed, is spent in hydrostatic testing of vessels, testing motors and compressors, checking piping for loose connections, etc. Plant should then be ready for startup, which usually requires up to three months.

These control points were planned by CCC's method of critical-path scheduling. Although they represent a schedule speeded up from that dictated for minimum engineering costs, they may be used as a standard for minimum-cost projects. Premium (overtime) man-hours were only 1% of the total.

Models' Man-Hour Savings: Almost all engineering contractors now make scale models for plant layout and piping designs. They have discovered hidden savings by using models to supplement the usual complement of engineering design drawings, thus visualizing the design in progress. These savings will pay for the cost of a model. Also, more contractors now use models to replace plans and elevations drawings. Since a $100,000 project may require 10-12 of these drawings, each consuming 300-400 man-hours of work, the savings can be considerable — and this time-savings is reflected in the project schedule.

How the schedules are affected is shown by comparing Crown Central project's engineering design man-hours with those typical of projects undertaken a few years ago.* According to its standard procedure, CCC substituted design models for plans and elevations drawings on this project, then it detailed the piping in isometric drawings. Result: the percentage of total design man-hours applied to piping and model work was about 45%, compared with a conventional figure of 55%. Adjusting these figures against total man-hours indicates an over-all savings of 15-20%.

Purchasing Payoff: Unlike the utilization of models, the critical-path system is not designed to shrink schedules by reducing the number of man-hours. On the other hand, it merely identifies the critical sequence of operations so that extra workers or overtime can be assigned to those jobs.

But CCC engineers found that by eliminating confusion, the critical-path system brought an unexpected bonus: man-hours required for purchasing and expediting (normally almost as much as for piping design) were reduced by an average of about 15%.

Savings stem from two sources: (1) expediters follow only those items that require expediting, and (2) suppliers know that the system specifies delivery dates according to necessity. CCC's records show that its overtime payments to fabricators were negligible (although the fabricators sometimes assigned overtime to recover from mishaps that resulted in deliveries behind the contracted date).

CCC, experienced with critical-path scheduling, is one of the foremost exponents of the technique among U.S. engineering contractors. The company has adapted it to regular plant maintenance as well as to control of its engineering design and construction projects.

* For a discussion of scheduling in general see *Project Engineering of Process Plants*, by Rase and Barrow (Wiley).

Other chemical process firms use the technique, too. Du Pont, for one, has devised a program called "arrow diagraming." It has been used in expansion projects at eight Du Pont plants, primarily to keep the lid on design and construction project costs.

Pulling Process into Line: It appears that the combination of model techniques with critical-path scheduling has just about reached an optimum for the tail-end of today's projects. But the front-end, process engineering, remains a major bottleneck. And the schedule for Crown Central's plant also illustrates this. While process man-hours consumed only 12% of the total, the engineering stage accounted for about 20% of the total time delay (between the time process flow is done and engineering flow is completed). CCC engineers are wary of moving ahead until a process design is final.

Process engineers, however, give good reasons for their delays: their work is more original and creative; it requires infinite calculations involving trial-and-error; and there is very little process work that can be put into a routine.

It seems, generally, that the only way for future projects to pull out of this bottleneck is through the use of computers; many companies have already installed computers for this purpose. As more systems of process design are programed for computers, experienced engineers will be freed from the trial-and-error tedium to concentrate on novel processing ideas and calculation sequences.

CCC says that while schedules are generally shrinking, the over-all costs of engineering and construction are growing. Three or four years ago engineering costs were 6-8% of a plant's total installed cost; now they are 8-9%. And three or four years ago construction costs were 17-19% of the total; now they are 18-20%. Reason: rising wages.

Since engineering and construction costs are tied almost directly to the national wage index, and as long as wage trends continue upward, man-hour savings will have little effect in halting rising project costs. However, faster construction does mean that the plant could start paying off sooner in return on investment.

Tail Gas Recovery

A novel process for recovering nitrogen from the tail gas leaving a nitric acid plant has been put into operation by Du Pont at Gibbstown, N.J. The Du Pont-Englehard catalytic process offers an attractive route for producers faced with the two-pronged problem of nitrogen oxide air pollution and relatively high prices for natural gas as raw material for ammonia synthesis.

Two systems are combined in the new route: (1) a Du Pont hydrogen purification system and (2) an Englehard Industries, Inc. (Newark, N.J.), catalytic system for converting the nitrogen oxides into nitrogen. Hydrogen resulting from steam-methane reforming is used to reduce the nitrogen oxides to elemental nitrogen and water. Nitrogen from the tail gas is used in a liquefaction-fractionation system to separate carbon monoxide and carbon dioxide from hydrogen in the reforming effluent.

In the process, nitric acid tail gas, containing 97-98% nitrogen in addition to nitrogen oxides, is passed through a scrubber to remove water vapors. It's then combined with a hydrogen-rich recycle stream of mixed hydrogen and nitrogen. The tail gas and recycle streams are controlled to give 10-20% hydrogen over that quantity theoretically required for the reducing reaction. The combined stream is passed through a palladium catalyst reactor, where the nitrogen oxides are reduced, then sent to a scrubber. Here, any remaining oxides are virtually eliminated (less than one part per million).

The hydrogen-nitrogen mixture leaving this scrubber is then combined with impure hydrogen from the steam-methane reformer, and the mixture is passed to the liquefaction-fractionation system. Here, the carbon monoxide and carbon dioxide from the reformer are removed; the recycle is separated as a side stream; and a synthesis gas containing hydrogen and nitrogen in a three-to-one volume ratio is produced.

Because of the complex interrelationship between nitrogen sources and reforming systems, the general economics of the process cannot be spelled out. Its developers claim, however, that it may prove attractive for a variety of special applications.

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Technology
Newsletter

CHEMICAL WEEK
August 26, 1961

A new method for increasing the strength of steel by cold stretching it with nitrogen has been developed by Arde-Portland, Inc. (Paramus, N.J.). In the technique, called Ardeorming, the steel is rolled and welded, then cooled to −320 F with liquid nitrogen and stretched with high-pressure gaseous nitrogen. So far, vessels fabricated from 301 stainless steel have been stretched approximately 13% in diameter. Tensile strength has been increased from 200,000-220,000 psi. to 260,000 psi.

Greatest usage for Ardeforming is expected to be in the production of rocket casings for solid-propellant engines. The technique will reduce the weight of an ICBM-class missile by about 1,000 lbs. And the strength increase will boost strength-to-weight ratio of steel casings of almost 1 million in.—within range of beta-titanium's 1.1 million in. and filament-wound glass fiber's 1.6 million in. (*CW Technology Newsletter, March 11*). The technique may also be used for fabrication of pressure vessels, tanks and high-strength tubing for the CPI.

Ardeforming, like other forming techniques such as Zerolling, is based on the improvement in ductility and tensile strength that is shown in austenic stainless steels by rolling and forming at sub-zero temperatures. However, in other processes the welding is performed after the steel has been worked at low temperature, cutting much of the strength improvement.

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New Synthesis techniques have been developed for making long chain aliphatic hydrocarbons by Quantum, Inc. (Wallingford, Conn.) in a research project for Humphrey-Wilkinson (New Haven, Conn.). The firm uses Wurtz and modified-Wurtz syntheses to make hydrocarbon waxes containing from 24 to 36 carbon atoms in high yields. In some cases, the firm says, yields have been 70% higher than those obtained in present commercial practice. Purities run as high as 97%.

Significance of the work: It provides a means for commercial manufacture of waxes such as tetracosane, octocosane, dotriacontane and hexatriacontane. Some of these compounds expand as much as 15% when melted, are potentially useful in thermosensing devices and thermostatic actuators in which, upon melting against a diaphragm, they provide a positive displacement. Using different waxes, it's possible to provide for a wide range of temperature control.

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Rights to an Australian system of alloying chromium have been acquired by Du Pont. The original work was done by Australia's Aeronautical Research Laboratories and the Defense Standards Laboratories of the Dept. of Supply. Du Pont obtained exclusive U. S. rights to the alloying process, also obtained rights to make the metal if the method

Technology
Newsletter
(Continued)

proves commercially feasible. If the firm decides to undertake commercial production, it will pay royalty fees to the Australian government.

Chromium is bidding for work as a structural metal at temperatures higher than the present operating limits of special nickel alloys but below those temperatures requiring columbium, molybdenum, tungsten or tantalum. Its main qualification is superb oxidation resistance. Its drawbacks: lack of ductility and susceptibility to nitrogen embrittlement. The Australian research has been aimed at overcoming these disadvantages via alloying.

•

Encapsulation as a technique for improving solid rocket propellants received a boost last week when National Research Corp. (Cambridge, Mass.) obtained a $250,000 contract from the Advanced Research Projects Agency. NRC has been working in the field for some time—to cultivate commercial outlets for the process as well as to develop advanced propellants.

Much of the current work on encapsulation is classified. But NRC is known to be working on a system in which the material to be coated is sent through a trough maintained under vacuum. The coating compound is heated by induction.

One of the probable goals of the work is to provide better storage characteristics for the propellant combinaion. Commercially, it might be an attractive means for making slow-release fertilizers or swimming-pool chemicals.

Others are working in the field, of course. Atlantic Research, National Cash Register and Southwest Research Institute have done considerable work, although the latter two are largely associated with encapsulating liquids. Aerojet-General also has a foot in the field, has obtained a license from NRC on its process.

•

A combination of solar energy and thermoelectricity may be economically feasible for irrigating many areas of the world. So said Kurt Katz, senior engineer at Westinghouse's new product laboratories this week as the firm unveiled a 50-watt prototype of a self-contained electric power plant and pumping unit. At the same time, Katz pointed out many variables that make it difficult to generalize on the cost of solar-thermoelectric power.

The prototype employs an 8-ft. parabolic mirror to focus the sunlight on the generator, which contains 72 thermoelectric elements. Westinghouse is currently working on a larger, 200-watt unit capable of pumping water from a depth of 20 ft. to irrigate four acres of land at the rate of 24 in. of water/year. To meet this demand the unit would have to operate 10 hours/day, 250 days/year; the safety margin is necessary to provide for cloudy weather.

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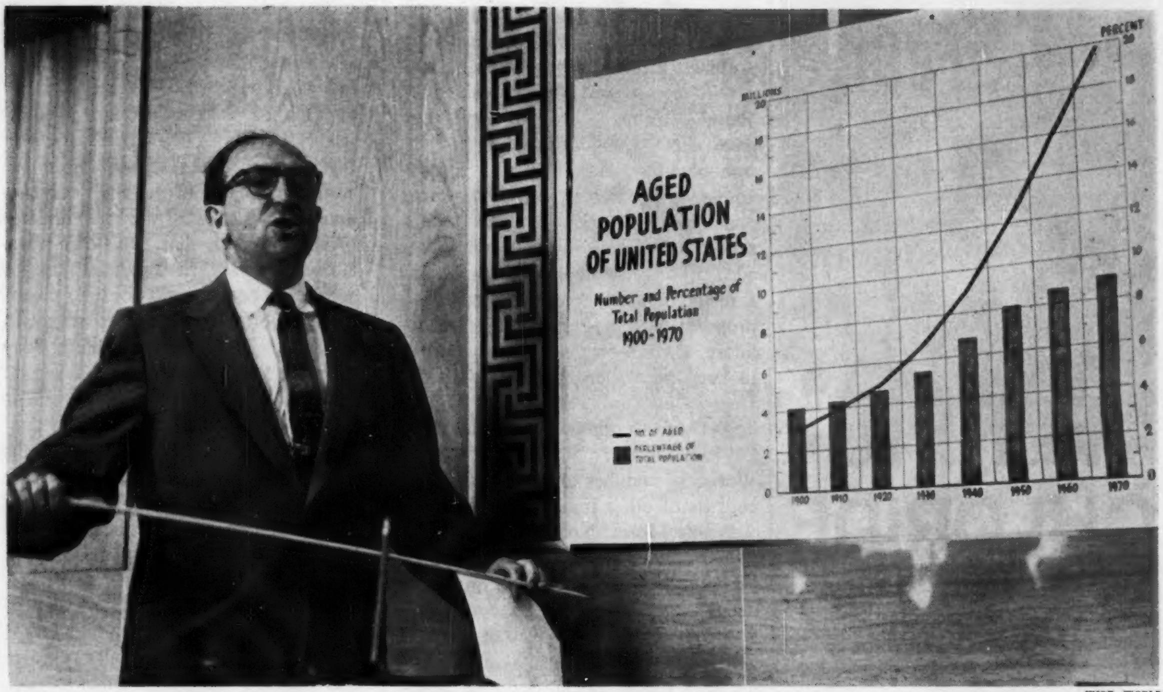


WIDE WORLD

HEW's Cohen believes that the government should not get involved in company pension plans.

CPI Unions to Push for Early Retirement

Chemical company pension plans won't be immediately affected by recent Social Security changes, according to a nationwide Chemical Week survey this week. But labor union spokesmen say they will seek a lower retirement age in future bargaining, since the new law drops the eligible retirement age (for men) from 65 to 62.

Most company plans now fix 65 as the retirement age. This should be lowered, contends the Oil, Chemical & Atomic Workers, so that pensioners can draw both company and Social Security benefits at age 62. OCAW notes that early retirement is "particularly attractive to workers 45 and up" because they feel that their jobs are threatened by automation and that early retirement will reduce unemployment.

The International Chemical Workers Union says it has traditionally used government pension provisions of various types (e.g., disability) as a guide in its bargaining. While the new Social Security law is no exception, ICWU observes, its bargaining objectives on pension benefits, as in other matters, depend on which plant the union is negotiating with. Pensions aren't as critical an item in a new plant having young workers but can be quite important if a plant's average age of workers is high.

Anti-Integration: Social Security cash benefits have been going up but so have taxes to pay for them. Starting Jan. '62 employers and employees will each pay $3\frac{1}{8}$% on the first $4,800 of an individual's earnings. This will climb to $4\frac{5}{8}$% each by '68.

Some companies having integrated plans (Social Security combined with company pension) are cutting back their contribution to the company plan to keep total benefits constant and to offset the higher Social Security tax. Other companies with plans of this type — e.g., Humble Oil, Socony Mobil, Olin Mathieson and Sandoz—contemplate no changes. Humble and Olin already provide for early retirement. For example, Olin employees having 20 years' service can retire at age 55, but Olin finds that employees frequently prefer to wait until they're 65 so they can get both Social Security and higher company pension benefits.

Both OCAW and ICWU oppose integrated plans. Few of OCAW's 750 contracts with oil companies are integrated, but about one-third of its more than 600 contracts with chemical firms are integrated.

The higher taxes that companies must pay toward Social Security also are expected to stiffen management's resistance toward more-liberal company pensions. One union executive says, however, that since fringe benefits are generally lumped in a "money package" during bargaining, higher taxes may well be considered part of this package.

Separate Tables: Among the companies with pension plans distinct from Social Security: Columbian Carbon, Borden Chemical, Union Carbide, U.S. Industrial Chemicals, Celanese, Stauffer, Wyandotte, Detrex Chemical (Detroit) and American

Cyanamid. None report changes stemming from the new law. Cyanamid, however, is completing a study of its benefits program, prior to installing uniform, improved plans.

CPI companies, in general, offer liberal retirement benefits. And they have demonstrated flexibility in pension planning. American Oil, for example, is offering an early retirement plan, complete with group hospitalization and life insurance, to employees aged 50-65 whose jobs may be lost as a result of a sweeping modernization program at the firm's Texas City refinery. Du Pont says it wants pensions to keep pace with the cost of living. Dow Chemical (Midland, Mich.), holder of an agreement with Local 12975, District 50, United Mine Workers, matches or exceeds fringe benefits of other industries in its area.

Wants More: No matter how generous company pension plans may become, they are considered only supplementary to Social Security by Assistant Secretary of Health, Education & Welfare Wilbur J. Cohen. He supports higher Social Security benefits, believes Social Security "should be the base of retirement plans" because many people do not have company pensions.

Cohen does not disparage integrating Social Security with other plans. Should Social Security be used to offset company benefits? Cohen tells CHEMICAL WEEK: "The relationship should be determined by collective bargaining; there is not and should not be a federal policy on diminishing company benefits by the amount one receives from Social Security."

Cohen says the next federal step should be medical aid to the aged. "Otherwise there will be increasing pressure to increase the amount of Social Security benefits to give retired persons enough income to cope with high medical bills."

Private pension funds had a book value of $50 billion at the end of '60, of which 38% was in insured corporate pensions (payable even if the company goes out of business). U.S. companies contributed 64% of the $4.4-billion income of these funds, employees 9%. The remainder came from investments ($1.1 billion) and other income. U.S. companies shouldering this load aren't keen on paying higher Social Security taxes, despite Cohen's enthusiasm.

Industry Prospects

The chemical industry's growth prospects have dropped in esteem among security analysts over the past two years, according to a new study by Opinion Research Corp. (Princeton, N.J.).

Part of a broad review of the investment image of leading corporations and industries, the new findings reveal, however, that 39% of 671 security analysts in financial centers across the country still consider chemicals one of the most attractive growth industries. But that's a sharp drop from the 59% posted in a similar ORC study in '58-'59. Says ORC, "The change in sentiment stems from concern with the impact made on profits by overcapacity, competition from nonchemical companies that are diversifying into petrochemicals and allied products and competition from foreign sources."

The industry's chief route to growth, according to the analysts, is in new products, especially plastics and building materials. Other opportunities, they say, are in space-age fuels and foreign expansion.

ORC's survey disclosed that the analysts regard the electrical equipment and electronics industry and the office equipment and pharmaceutical industries as having the best growth possibilities over the next five years. Railroad, automotive, steel, nonferrous metals and rubber industries are the least favored.

LEGAL

Florida Pollution Suit: The Florida State Board of Health (headquarters: Jacksonville) has filed suit in Polk County circuit court at Bartow against Virginia-Carolina Chemical Corp. The board is seeking an injunction to prevent V-C from dumping wastes into the Alafia River and to force the company to change its present method of waste disposal, which is alleged to have killed fish and created a hazard for livestock and human beings.

Justin Potter, V-C president, says his firm has taken "necessary corrective actions" and expects to solve the problem "in the immediate future."

Hans Tanzler, Jr., general counsel for the health board, believes it's the first suit filed by a Florida state

agency charging private industry with pollution of natural resources. The bill of complaint states that while V-C has "demonstrated a cooperative attitude toward the problem," it has not provided adequate treatment for waste. It also says that agents of the board contacted the company more than 35 times in an effort to halt pollution after citizens and community groups had complained.

According to the board, troublesome waste comes from the wet-process phosphoric acid plant V-C started up in June '60. Besides trying to halt the alleged pollution, the board wants the company to pay the cost of restocking the river and its branches with fish and to pay for inspections of the firm's disposal operations.

KEY CHANGES

Gerald Smith to vice-president of operations, Wellman-Lord Engineering, Inc. (Lakeland, Fla.).

John P. Miller to executive vice-president, **Eugene W. Morgan** to vice-president and treasurer, **James A. Borders** to secretary, **Hubert F. Crawley** to controller, **Joseph R. Hughes** to assistant treasurer, **James G. Dieter** to assistant treasurer, Spencer Chemical Co. (Kansas City, Mo.).

Robert C. Harnden to president and general manager, **A. Dale Chapman** to board chairman and director of research and development, Chapman Chemical Co. (Memphis, Tenn.).

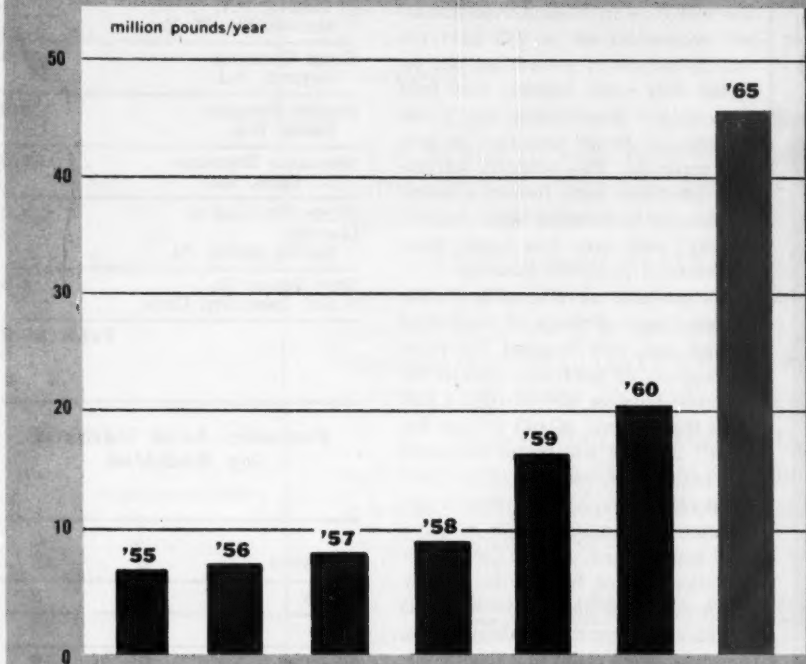
James R. Moss to executive vice-president, Marine Colloids, Inc. (New York).

Robert L. Hurley to vice-president of marketing, National Beryllia Corp. (Haskell, N.J.).

Fred W. Batten to president, **John W. Partridge** to board of directors, **Joseph A. Brake** to vice-president, Columbia Hydrocarbon Corp. (South Shore, Ky.), subsidiary of Columbia Gas System, Inc.

Fred G. Gronemeyer, Carl O. Hoyer and **William G. Luttge** to senior vice-presidents; **Arvon L. Davies, Paul W. Runge, Robert E. Smith** and **J. R. Crow, Jr.,** to vice-presidents; **Robert M. Crooks** and **Louis E. Dequine** to executive directors; The Chemstrand Corp. (New York), subsidiary of Monsanto Chemical Co.

Fumaric Acid Demand Starts Its Rapid Climb



Fumaric acid puts the zing into food products, encouraging its greater use by food makers.

Food and Drinks Fatten Fumaric's Future

Small-fry sipping drinks flavored with fumaric acid will continue to enrich the American scene now that the Food & Drug Administration has extended for two years its temporary okay of fumaric use in food and beverages.* The approval allows fumaric makers to continue uninterruptedly their bid for a share of the food acidulants markets; and it also lends weight to forecasts that at least 15 million lbs./year of the chemical will be going into food products by '65.

This predicted growth-burst—only about 2.5 million lbs. of this acid now goes into food and beverage uses—will be instrumental in hiking the over-all market for fumaric in '65 to about 46 million lbs. And '65 will be the year, according to many market observers, when food applications will take as much fumaric as will polyester resin-making (now by far the prime outlet).

Late Starter: In both food and resin applications, fumaric has been a late starter. The *trans* isomer of widely used maleic acid, fumaric is an old-timer. But even by '58, its total sales were still less than 10 million lbs./year. Then, in '59, demand vaulted to 16 million lbs.; and an additional 4.5 million lbs. were used in '60, largely because of the growing use of polyester materials. Capacity has been ample and will likely remain so—since fumaric is readily made in many facilities designed for maleic.

So far, food markets have not been as important to fumaric makers as polyester and alkyd resin markets have been. But activity in several research areas speaks plainly of the potentials the food field may hold.

This week in Philadelphia, for example, a research firm, LaWall & Harrisson, is winding up a one-year animal feeding study on the toxicity of fumaric. So far, all clinical tests have been completed; the final tissue experiments should be completed by the end of this month. According to industry sources, the tests have been "extremely promising." The consultant's report, industry hopes, will soon help convince FDA that fumaric belongs on the GRAS (Generally Recognized As Safe) list.

Permanent FDA sanction—expected long before the current extension runs out—will be the convincer to many food users who have been tempted by fumaric's low price (27¾¢/lb.) but put off by its lack of the FDA-okay carried by more expensive acids, such as citric (currently tagged at 29½¢/lb. in drums).

Right now, citric acid is the kingpin in the food acidulant business. In '60 about 55 million lbs. went into a myriad of food products, such as gelatin deserts, beverages, hard candy, fruit juices, leavening agents, flavors. But already fumaric displays enough price and performance characteristics over citric—e.g., it is relatively noncaking in dry powders—to be a real threat to citric acid markets.

Room to Grow: Other end-uses of

* *Federal Register,* Aug. 15, '61, p. 7545.

fumaric seem due to expand also during the next five years.

Polyesters, which took the lion's share of '60's production—8 million lbs., 40% of the total output—doubtless will grow in volume. And fumaric's proponents say it will gain not only by polyesters' growth but also by taking over some business now held by maleic. Fumaric, they say, yields polymers of better resistance to heat and corrosion. This property advantage, combined with fumaric's safety to animals (contrasted with maleic's toxicity) may give it a larger piece of the total polyester business.

But probably more important is the expected rapid buildup of reinforced plastics and thus demand for polyesters. Sales of reinforced plastics hit 250 million lbs. in '60—two and a half times the '55 level of 100 million lbs. By '65 demand will be an estimated 475 million lbs./year.

Alkyd Angle: Another sizable application for fumaric acid is in alkyd resin manufacture. Alkyds took about 5 million lbs. of fumaric in '60; by '65 demand will likely grow to about 8 million lbs./year. In this use, too, fumaric makers claim that their product is superior—that it yields harder resins with better high-temperature characteristics than maleic-based alkyds.

Fumaric's market growth prospects in this use are mixed. Despite the fierce competition by nonalkyd water-based coatings, the alkyd resins are expected to register a slight market gain during the next five years. But after '65 a decline in alkyd paint demand can be expected.

Plenty of Jobs: Fumaric acid has a raft of other uses—e.g., in the manufacture of rosin adducts, plasticizers, and the like. In '60 these miscellaneous applications consumed about 5 million lbs. of fumaric, and by '65 their total take will advance — but perhaps only to about 8 million lbs./-year.

Although fumaric acid demand for all uses will likely register a 225% gain during the next five years, adequate capacity is already in place to take care of this burgeoning demand. There are currently six companies with plants at seven locations. Their total output potential: about 56 million lbs./year.

Monsanto and Allied Chemical are by far the largest U.S. fumaric acid producers and collectively account for 30 million lbs./year of production capacity—53% of the U.S. total. The other companies in the producers' lineup include Heyden Newport, Pittsburgh Chemical, Bzura and Utah Resins Co. Although Pfizer is not currently a fumaric acid producer, it is an important factor in the food acid market, and should be able to maintain a healthy share of the future market for food-grade material.

Pfizer is the major U.S. marketer of citric acid and is currently reselling food-grade fumaric acid, reportedly from Allied Chemical. Pfizer will likely jump into production when food-grade fumaric markets grow. Miles Laboratories, the other major citric producer, is also watching fumaric's progress, but has no immediate plans.

In sum, the hub of activity for fumaric acid producers is the chemical's food applications, and permanent sanction in this use by the Food & Drug Administration is vital. Now that it seems to be almost at hand, look for rapid market growth.

Fumaric Acid Producers and Capacities

(million pounds/year)

Allied Chemical Buffalo, N.Y. Moundsville, W. Va.	**15.0**
Bzura Chemical Keyport, N.J.	**7.5**
Heyden Newport Fords, N.J.	**8.0**
Monsanto Chemical St. Louis, Mo.	**15.0**
Pittsburgh Coke & Chemical Neville Island, Pa.	**8.0**
Utah Resins Co Salt Lake City, Utah	**2.5**
Total	**56.0**

Fumaric Acid Demand by End-Use

(million pounds/year)

	'60	'65
Polyesters	8	15
Alkyds	5	8
Food	2.5	15
All other	5	8
Totals	20.5	46

The U.S. aluminum industry laid bare its import-export problems before a House of Representatives subcommittee last week, hoping to persuade the federal government to smooth out some rough spots in foreign competition.

One plaint: U.S. exports of aluminum products increased only 3% in the past 10 years, while imports shot up 270%, to more than 83 million lbs./year—more than twice the export volume. One proposal: establish an international quota system.

Spokesmen for top U.S. aluminum producers agree on the need for better tariff deals. Lewis Favorite, vice-president of Aluminum Co. of America, urged the U.S. government to push for reduction of primary aluminum tariffs of all GATT (General Agreement on Tariffs and Trade) members down to the U.S. level—about equivalent to 5.3% ad valorem.

Through GATT negotiations U.S. tariffs on primary aluminum have been reduced from 3¢ to 1¼¢/lb. since World War II. U.S. producers now think the time has come for comparable concessions from other major aluminum producing countries.

Meanwhile, improved aluminum business conditions at home spurred Kaiser Aluminum & Chemical to reactivate production to full capacity last week at its Chalmette, La., reduction plant.

Production at Chalmette was cut back to well below 50% of capacity last summer. By June '61 eight of nine potlines were back in operation; reactivation of the ninth line brings production close to full capacity of about 247,500 tons/year.

The company's optimism was also reflected in testimony of Kaiser's Vice-President, Ward Humphreys, at the House subcommittee hearings. Humphrey's prediction: U.S. aluminum industry will double in size by '70.

But aluminum producers are busy skirmishing for better holds on alumina markets in abrasive, electronic, ceramic and other consuming industries. Both Aluminum Co. of America and Kaiser Aluminum last week posted price cuts up to ½¢/lb. on various grades of aluminas; Kaiser tossed in one price increase, which should help to compensate for cuts on other grades.

Kaiser knocked $10/ton off tabular alumina KT-1060 and off low soda granular alumina KC-10; granular alumina KC-1 was reduced $1/ton. However, price of high-fired KC-2 was boosted by $2/ton.

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American Cyanamid's 2¢/lb. phthalic anhydride price cut smashes hopes of marketers who for many months have soft-pedalled likelihood of a price break in '61 (*CW Market Newsletter, May 20*).

Market

Newsletter

(Continued)

"Weakened" market conditions, says Cyanamid, call for reductions to these levels: 17½¢/lb. in bulk, 18¢ in bags, c.l., and 19¢/lb. lcl.

Now that the price cut is at hand, competing companies say the move came as "no surprise." Only question has been who would be first to try to boost demand with lower prices. Immediate reaction of other phthalic marketers: they would waste no time following suit.

Will Phthalic prices hit the 15¢/lb. level some have predicted? That probably depends on how much demand is bolstered by the current 2¢ reduction during the next six or eight months—by which time several new phthalic plants will be nearing completion (*CW July 1, p. 16*).

And competitors in the phosphates industry are going along with Monsanto's 17¢/100 lbs. price shavings on sodium tripolyphosphate (now \$7.18/100 lbs. in bulk) and on tetra sodium pyrophosphate (now \$6.83/-100 lbs.); both prices f.o.b. Bridgeville, Pa., freight equalized.

Price cuts on these detergents-making raw materials are not attributed to softening markets; Monsanto reports combined U. S. sales of STP and TSPP were over \$115 million in '60 and are showing "excellent increase" this year. Reasons for cut: "steady growth" of markets, "Advanced production technologies."

New reason for broadening phosphate markets now: Monsanto will build a new plant to make phosphoric acid and sodium tripolyphosphates at Augusta, Ga. by early '63. Details are not yet revealed.

•

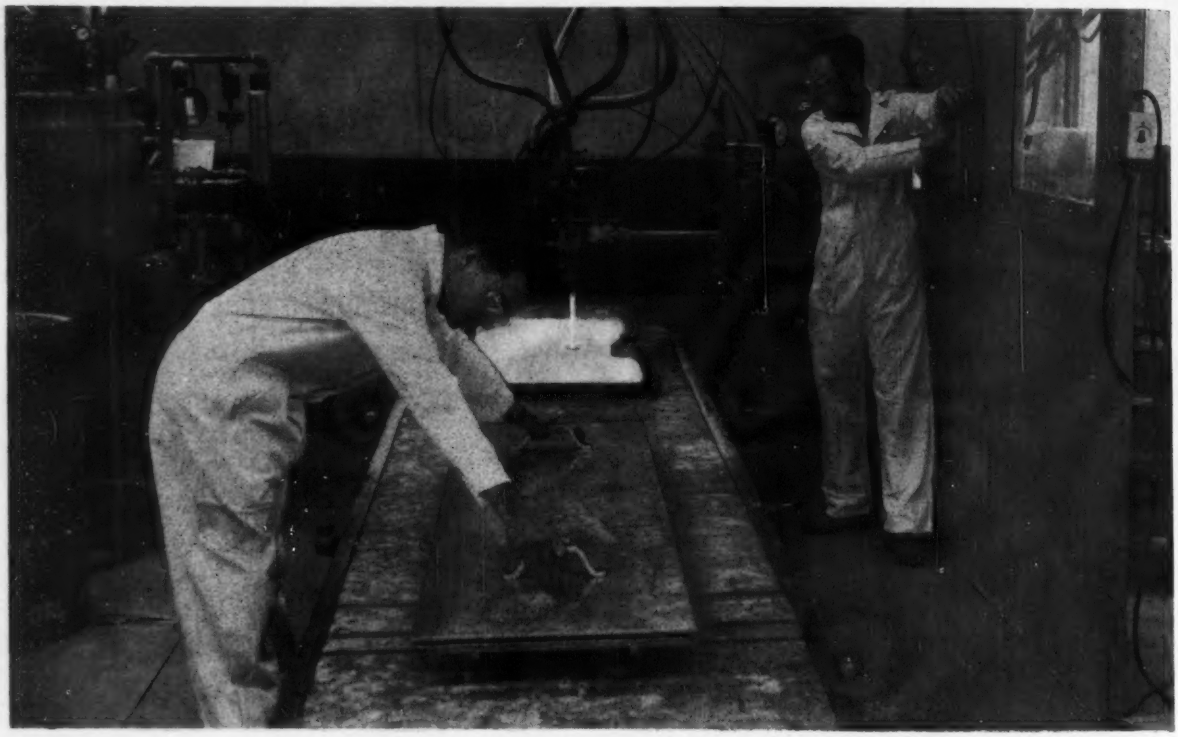
U.S. Bureau of Mines' proposal to jack helium prices to \$35/-1,000 cu.ft. in bulk quantities (*CW Market Newsletter, Aug. 19*) is expected to boost helium sales volume from \$9.5 million/year (value of sales in the past 12 months) to \$21 million during the first 12 months at the new price. Actually, physical volume will change little over the next 12 months. The price hike will account for most of the increase in dollar sales. By '64 sales will rise and income will probably increase to \$27.5 million/year. (The proposed price change is being published in the *Federal Register* for public comment).

Last week the government signed its first helium conservation contract with Helex Co., subsidiary of Northern Natural Gas of Omaha, Neb. It calls for construction of the nation's largest plant—700 million cu.ft./year—for extracting raw helium from natural gas, probably at Bushton, Kan.

The 22-year contract with Helex is expeeted to cost the government about \$209 million for about 15.4 billion cu. ft. of gas. Expenditures amounting to about \$1 billion during the next 25 years, to conserve 52 billion cu. ft. of gas, are anticipated.

Government officials say another helium conservation contract is about ready for signing and that many others are being negotiated; the maximum program could bring to 12 the number of private helium plants to be put into operation.

Cut foam production costs



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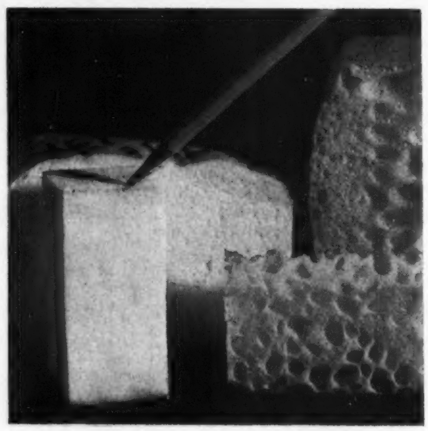

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Tailoring Better Polymers

Basic new discoveries in making block and graft copolymers point the way to materials that combine the best features of two conventional polymers.

CPI researchers heard what they expected on block and graft copolymers (*right*) at last month's International Symposium on Macromolecular Chemistry at Montreal: more reports on fundamental aspects, but precious little on commercial application. Underlying the technical tone of the papers, however, was overt interest in new techniques to tailor "salable" properties into polymer molecules.

The heavy emphasis on fundamentals rather than commercial results has two roots: (1) a continuing need for basic information on ways to make, separate, analyze and predict the properties of new block and graft copolymers (in spite of the advances in these areas since the mid-'50s) and (2) a spirited patent race in which firms are busily trying to establish positions in the field.

Nonreactive? Relatively new methods that can combine polymers previously considered unreactive are the target of much of the recent work. Catalysis, radiation, photolysis and mechanical shearing are supplementing systems that rely on functional groups to make the segmented copolymers.

End result: copolymers that retain the best properties of homopolymers of each monomer. Conventional random copolymers result in a compromise of these properties.

Among the many commerical end-uses for which block and graft copolymers have been proposed (and in which some are already serving) are surface-active agents, high-impact plastics, structural adhesives, thermally resistant and easily processed rubbers, high-strength fibers and polymeric coatings.

Examples of other applications that are at least in the laboratory stage: grafting acrylonitrile to polydimethyl siloxane rubber to reduce swelling in hydrocarbons; grafting vinyl carbazole to polyethylene to combine the heat resistance of polyvinyl carbazole with the workability of polyethylene; making ion-exchange resins with improved physical strength based on grafts of styrene to polyethylene.

A spokesman from W. R. Grace expands the list of potentialities for polyolefins: better printability, dyeability, low-temperature serviceability and selective permeability to liquids and gases.

Company Interest: Most firms are willing to admit that they are working in the field, but are reluctant to give details. To date, the patent literature has been the best source of information on the lines followed by various firms. For instance, Dow Chemical has a number of patents involving radiation-induced grafting. It also has a French patent (1,246,158) on a fiber-forming system based on polymerizing acrylonitrile in the presence of polyvinylpyrrolidone in an aqueous solution of ethylene carbonate, dimethyl sulfoxide or butyrolactone. And it also holds a British patent (855,720) on reacting a polyolefin fiber (e.g., polypropylene) with ozone, then grafting on acrylonitrile. Results are understood to be reduced shrinkage and higher strength and dyeability.

An early U.S. patent in the field (2,907,675) is held by Du Pont on radiation grafting for coatings. And Du Pont's work on elastomeric block copolymers for fibers paid off in commercialization of Lycra urethane fiber.

High-impact polystyrene and acrylonitrile-butadiene-styrene copolymers are examples of recently commercialized graft copolymers. Goodyear Tire & Rubber Co., for one, holds an Australian patent application (57,527) on an impact-resistant, rubbery copolymer: acrylonitrile grafted on a polymer backbone containing butadiene and small amounts of acrylonitrile and styrene. A similar composition is also described in the firm's British patent (866,667) on rubbery graft

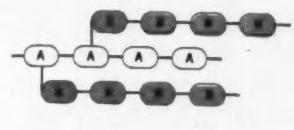
DIMENSION

New Techniques in Polymer Architecture

Researchers are developing a new way to put desired properties into polymer molecules: they are fashioning copolymers that are made up of controlled polymeric segments rather than randomly distributed monomer fragments. The two basic types:

Block copolymers, in which segments join at the ends—

Graft copolymers, in which one segment grows from the side of the chain—



Starting materials are generally a polymer and a monomer, although two polymers or two monomers may also be used. Through control of materials and conditions, lengths of the individual segments can be controlled, as can the size of the total polymer molecule. Here are the five approaches being tried:

(1) **Chemically reactive polymers:** Simplest method is to react a monomer directly with a polymer that contains functional groups (e.g., hydroxyl groups, amino groups, double bonds). Most commercial segmented polymers are of this type. If the functional groups are along the polymer chain, graft copolymers are formed; if at the ends of the original polymer molecule, block copolymers result.

(2) **Catalytic reactions:** Polymer chains that contain no functional groups can be made reactive by use of selected conditions and catalysts (usually peroxides).

(3) **Radiation:** Powerful tools for activating polymers are electron and gamma radiation. Surface modification of polypropylene and Teflon are two of the targets of this work. High cost and scale-up of radiation sources are the big problems.

(4) **Photochemical reactions:** A specialized approach is the use of polymers that contain a photosensitive group (e.g., bromide) or the use of a photochemical initiator.

(5) **Mechanical degradation:** Physical grinding and ultrasonic irradiation have both been used to form segmented polymers.

copolymers suitable for decorative film coverings for walls.

Graft copolymers suitable for use as lubricating oil additives have been patented by Esso Research and Engineering Co. (British 852,949) and Rohm & Haas (British 855,711), both routes involving radiation.

Linkup Spots: A number of conventional copolymers and cured polymers fit the definition of block and graft copolymers, but are formed simply by reaction of functional groups in the starting materials. Urethane polymers, for instance, are basically block polymers of polyesters or polyethers joined by diisocyanates. And block copolymers are formed when more than one starting polymer is used. Polyamide-cured epoxy resins typify the combination graft-block structure formed by cross-linking polymer chains with other polymers.

Wyandotte's Pluronic line of surface-active agents are actually block copolymers formed by polymerizing propylene oxide, then polymerizing ethylene oxide onto the end hydroxyl groups of the polypropylene oxide. And hydroxyethyl cellulose, made by polymerizing ethylene oxide on the hydroxyl groups of a cellulose chain, is a commercial graft copolymer.

What's Going On? However, basic work is still needed, even in this relatively well-explored method of producing block and graft copolymers. A problem common to all methods concerns controlling the side reactions. Most bothersome is formation of homopolymer by one or both starting materials. In addition to cutting product yield, such reactions cause difficult problems of detecting, measuring and separating the desired product. Two papers at the Montreal meeting dealt with determination of grafting efficiency in chemically reactive systems.

In one, Murray Goodman of the Polytechnic Institute of Brooklyn described a way to determine the efficiency of vinyl grafts on a modified cellulose diacetate. Measured by turbidometric titration, the amount of graft polymer obtained was 62.5% with methyl methacrylate, 60% with acrylamide, 51% with acrylonitrile, 40% with styrene, and 25% with methacrylic acid. Further studies are planned to correlate grafting efficiency with temperature, monomer concentration and grafting site concentration.

From the University of Louvain (Belgium), G. Smets reported on similar studies, including the relative reactivities of functional groups on the side and the end of the polymer chain. The mechanisms of polymer initiation, chain propagation and termination steps were compared with the efficiencies found to explain why some monomers and reactive sites are more reactive than others.

Even when the starting polymer lacks functional groups, it can often be given such groups by peroxidation. Stable peroxy groups along the chain form ideal sites for grafting. This is one approach being taken toward rendering polypropylene fiber dyeable; peroxidation allows the grafting of dye-accepting monomers to the surface of the fiber.

Catalytic Help: Peroxides and other free-radical sources are also important catalysts in the grafting of monomers onto polymer chains that have no functional groups. Benzoyl peroxide and azobisisobutyronitrile are the two best-known initiators for block and graft copolymerization in homogeneous systems (including bulk systems — polymer dissolved in monomer—and solvent systems). Potassium persulfate and redox initiators — e.g. ferrous ion and hydrogen peroxide — are commonly used in emulsion systems. Ionic copolymerization reactions can be catalyzed by boron trifluoride and sodium, for instance.

Michael Szwarc of Syracuse University's State University College of Forestry has worked for some time on the formation of nonterminating polymer chains by catalysis with ionic complexes of sodium and aromatic hydrocarbons. In these systems, called "living polymers," the chain grows until all the monomer is used up; addition of another monomer causes reaction with the still-active polymer chain and results in a block copolymer.

A group of papers coauthored by Szwarc at Montreal gave evidence of continued interest in further development of this technique. ("Living polymers" made with Ziegler catalyst systems have been reported by Farbwerke Hoechst.)

T. Toda of Toyo Spinning Co. (Katata, Japan) described the use of sodium periodate to increase the reaction of vinyl monomers with cellulose. And Kyoto (Japan) University's

Junji Furukawa and Takeo Saegusa reported that stereoblocks (alternating stereoregular blocks within a homopolymer) can be formed in polyacetaldehyde by using a combination of cationic and anionic catalysts.

Radiation Power: Use of gamma or electron radiation to activate normally inert polymers has received a great deal of attention the world over. Modification of polytetrafluoroethylene surfaces to improve adhesion and printability is one of the aims of this work. Adolphe Chapiro of the National Scientific Research Center (Bellevue, France) reported to the Montreal meeting on the effect of temperature on the degree of radiation required to graft styrene on the surface of polytetrafluoroethylene film rather than throughout the film. This "critical intensity" was found to be about 1 rad/second at 40 C, compared with 6-8 rads/second at 19 C and over 35 rads/second at 60 C. In another report coauthored by Chapiro, the crystallinity of polytetrafluoroethylene was found to diminish with increasing styrene grafting.

Also at Montreal, four researchers from Radiation Applications Inc. (Long Island City, N.Y.) reported that the amount of styrene copolymerized with other monomers when grafted with gamma radiation was less than the amount that was calculated from the standard Lewis-Mayo equation for determining copolymer composition. And Dow Chemical's R. A. Mock and W. N. Vanderkooi described the determination of kinetic constants in vinyl grafting, using as an example styrene grafting on ethyl cellulose film activated by electron radiation.

Radiation systems have taken on added interest in the past few years as it was found that the reaction mechanism depends on the temperature. Originally used for free-radical polymerizations, radiation techniques have proved to result in ionic polymerizations at lower temperatures, the transition temperature depending on the reaction system.

Other Routes: Photolytic reactions can be used in several ways to initiate block and graft copolymerization. Use of photosensitizers that form free radicals in the presence of light (e.g., anthraquinone dyes) is the key to one method. Polyketones are light sensitive, yielding free radicals, as are polymeric bromides made by polymerizing a monomer such as styrene in the presence of carbon tetrabromide. In each of these compounds, grafting can occur at the free-radical site.

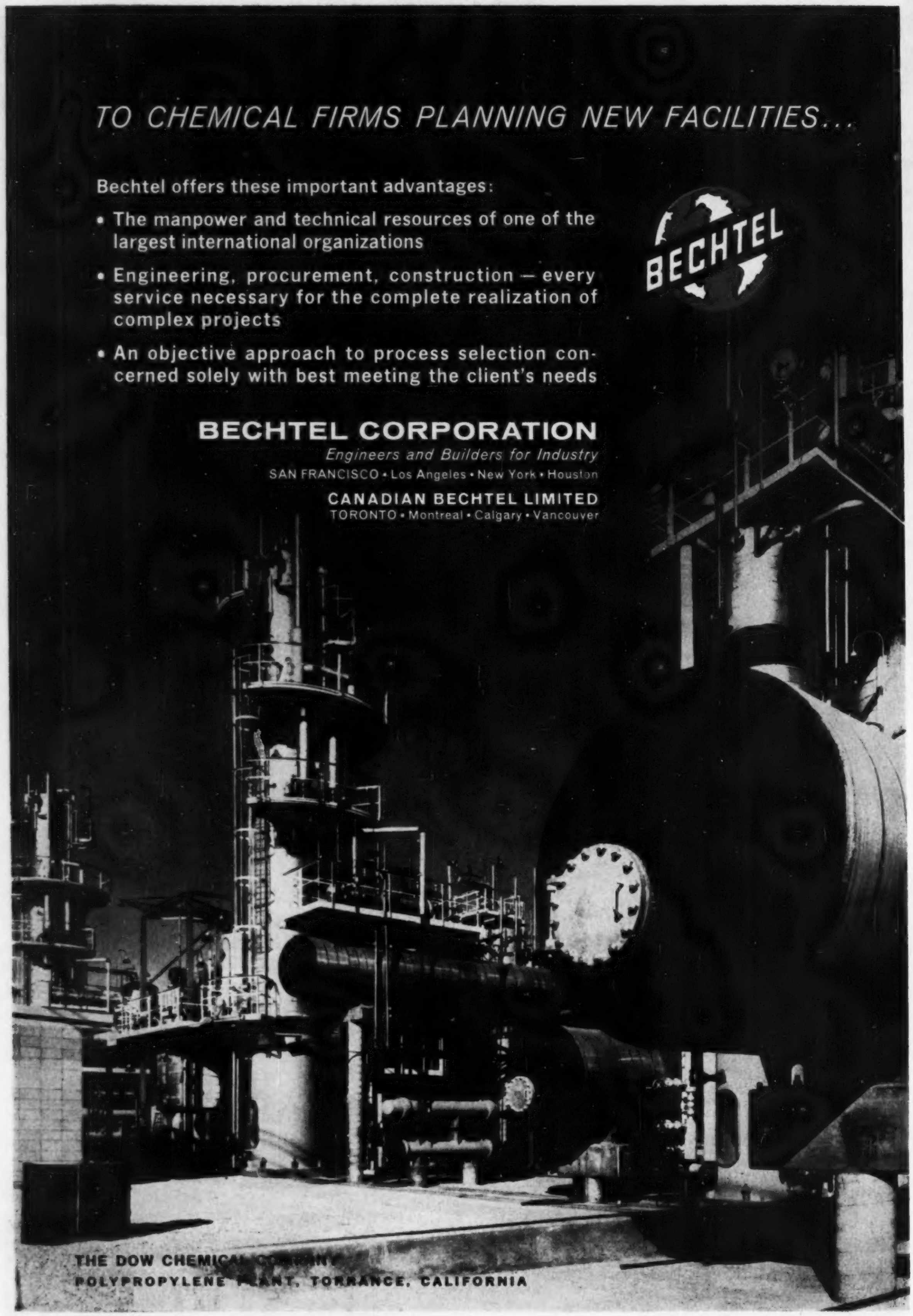
A self-lubricating rubber has been developed by Quantum, Inc. (Wallingford, Conn.), using a photolytic method. Methyl acrylate is grafted to natural rubber in the presence of ultraviolet light. The product is hydrolyzed and fluorinated to produce a very low friction rubber for potential use in gaskets and seals.

Mechanical degradation of polymers has also been used to make block and graft copolymers. Shearing forces (whether applied by a mill, grinder, ultrasonic wave or other source) can actually break polymer chains, leaving the ends active as free-radical sites. This technique — developed by British Natural Rubber Producers Research Assn. — has been used in Great Britain to make a commercial block copolymer of natural rubber and methyl methacrylate.

Industry has clearly only scratched the surface in the utilization of block and graft copolymerization techniques to fashion improved products. But if the amount of research going into the subject is any criterion, there will be plenty of block and graft products on the way.

LITERATURE

- English translations of five Russian publications on solid-electrolyte fuel cells are available from stock from Associated Technical Services, Inc. (P.O. Box 271, East Orange, N.J.). Prices range from \$6.30 to \$22.75.
- "The Encyclopedia of Spectroscopy" (787 pages, \$25) and "The Encyclopedia of Microscopy" (693 pages, \$25) are two recent publications of Reinhold Publishing Corp. (New York). Both are collections of articles by contributing authors edited by George Clark of the University of Illinois.
- Unclassified reports of the Armed Services Technical Information Agency (ASTIA) are now available through the Commerce Dept.'s Office of Technical Services (OTS). They will also be listed in OTS's periodical, "U.S. Government Research Reports," which is now being published twice a month instead of monthly.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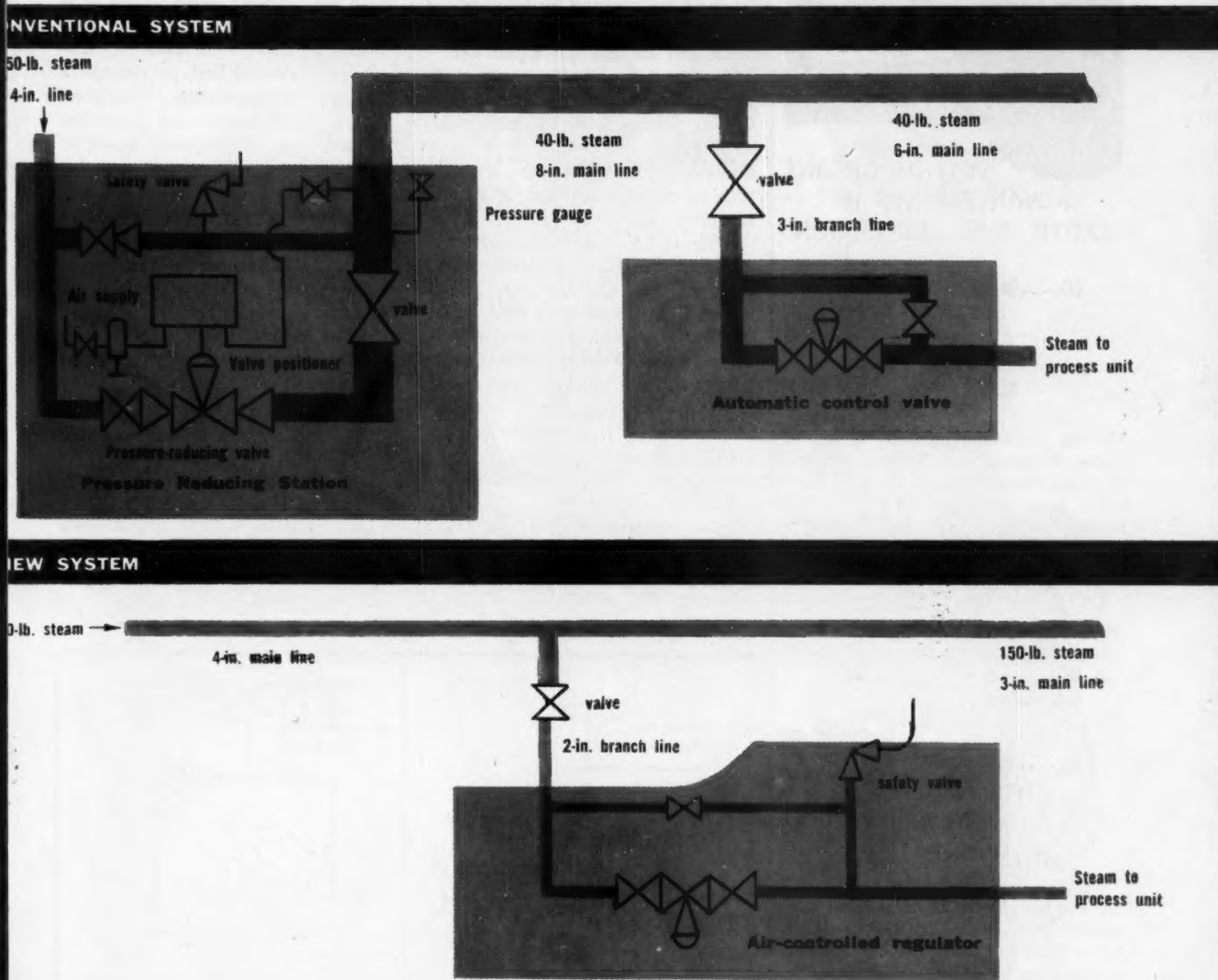
How new high-pressure steam distribution system cuts installed cost 43%



Throttling Process Steamline Costs

Last week Ernest Grafe, field engineer for Spence Engineering Co. (Walden, N.Y.), brought in an order for steam regulation equipment for a Southwest chemical plant—the first chemical industry trial of a new steam distribution system. It's claimed to cut installation costs over 40% and improve control of process heat.

The system permits distribution of process steam throughout a plant at one pressure, eliminates the common need for several piping systems to provide steam at different pressures for specific operations. Also, the Spence system is usually installed with a high-pressure, small-diameter "main," which is cheaper to put in than larger-diameter, low-pressure steam piping (*diagram, above*).

Moreover, says Spence, its system actually gives better control of process heat. This is because the air-pressure control loop operates on the cascade principle—i.e., it makes immediate changes in steam flow rate when steam pressure varies, follows up with finer adjustment when steam pressure change results in process temperature change (*Dimension, p. 76*).

Start with Regulators: Spence laid the groundwork for the new system

about one and one-half years ago when it developed a broad line of air-loaded, steam-piloted regulators—valves that are positioned by steam tapped from the steamline, with the positioning force, in turn, air regulated (through a diaphragm in a pilot chamber, where line steam pressure is opposed by air at a preset pressure). Grafe points out that air-loaded, steam-piloted regulators have been available for about 20 years, but only with air-pressure loadings of limited range.

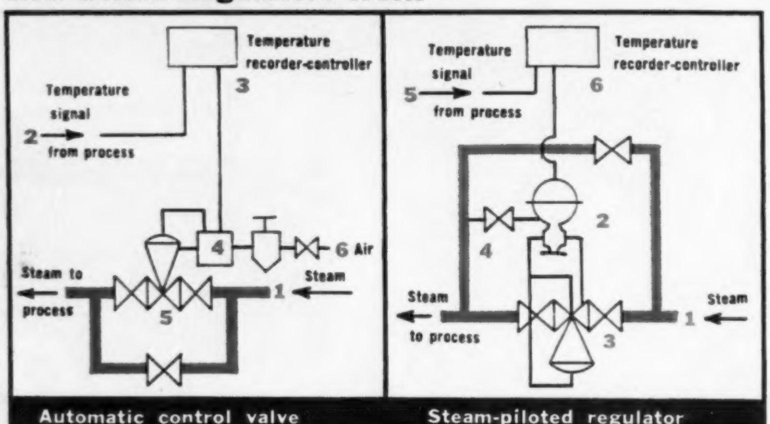
With the new line of regulators, processes requiring different steam pressures (e.g., 125 and 35 psi.) can be fed from a typical 150-psi. steam distribution system. The only need is to install one of the wide-range regulators (with the necessary loading) at each process point. Precise temperature control of each process is provided by an ordinary pneumatic temperature controller connected to the regulator's pilot. With a change in process temperature, the controller changes the air loading of the regulator to change the steam flow rate (aside from any changes produced by main-line steam-pressure changes).

In most process plants, steam pressure and process temperature are controlled separately. For example, 150-psi. steam would first go through a pressure reducing station, where pressure is cut to 40 psi. and distributed to the processes requiring steam at this pressure or below. Process temperature control is commonly obtained with a pneumatic temperature controller that signals a valve positioner, which controls the steam-valve opening with a compressed air driver.

Food Industry Trial: Thus far, the only system installations have been in small food processing plants, where cost savings have been relatively small. For example, at Whiting Cheese Co. (Gillett, Wis.) the system was installed on a milk pasteurizer. The air-operated temperature-control valve was eliminated with the installation

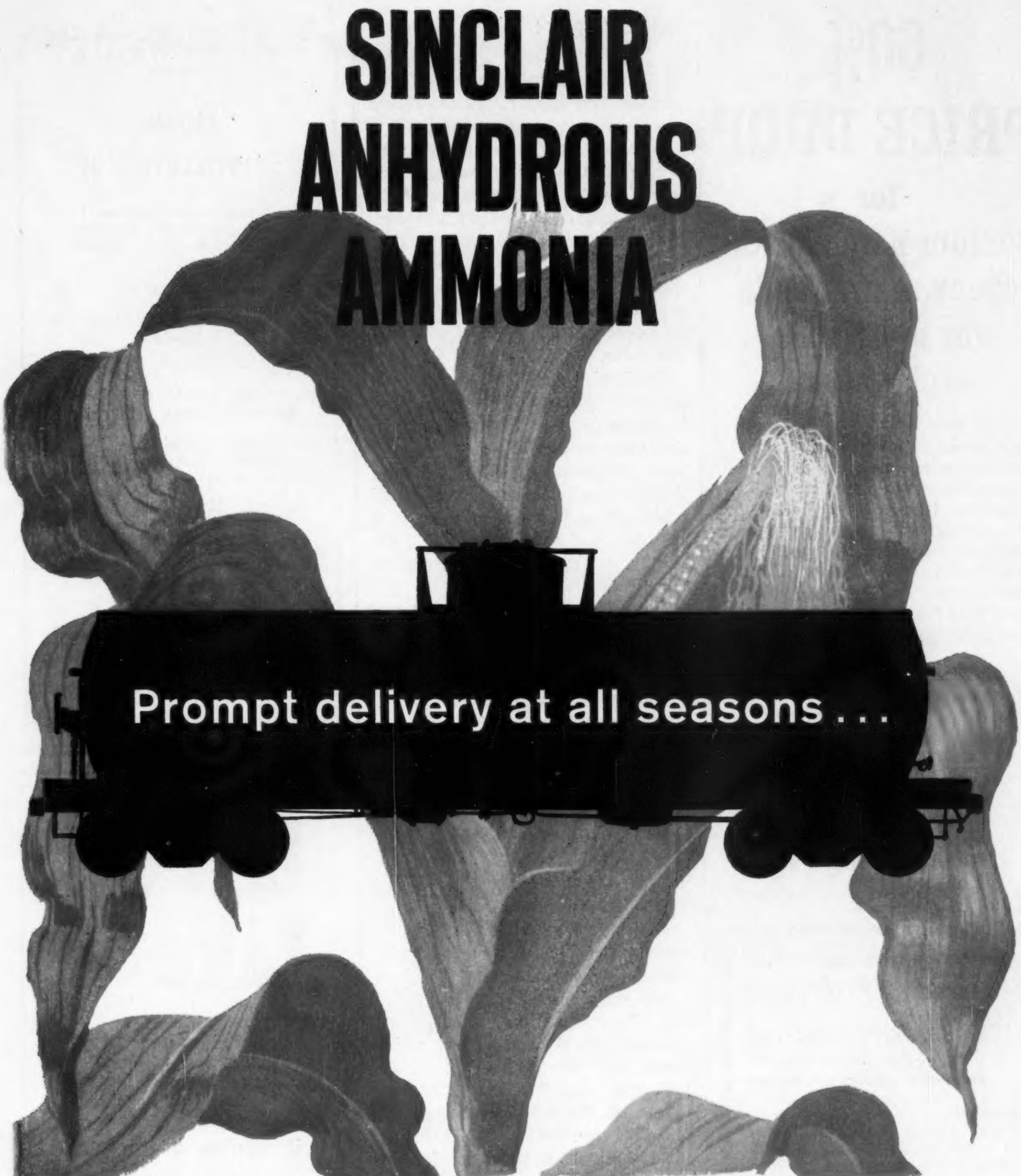
DIMENSION

How Steam Regulators Work



Change in steam pressure from main line (1) causes temperature change in process. Change in temperature signal from process (2) causes temperature recorder-controller (3) to send new air signal to automatic control valve positioner (4), which resets opening of steam control valve (5) using compressed air (6) as driving force. Valve is used in conjunction with pressure reducing valve, which is main pressure control for steam supplied to steamline (1).

Change in steam pressure from main line (1) causes change in pressure on diaphragm in pilot (2), which is loaded with air at preset pressure. Change in pressure on diaphragm triggers reset of regulator control valve (3), which uses line steam (4) as driving force. Final adjustment of valve is made by change in temperature signal from process (5), causing temperature recorder-controller (6) to send new signal to load pilot (2) with air at new pressure.



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of the regulator valve to control both pressure and temperature. And both process-control accuracy and stability were improved. Operating costs were reduced because air is now used only to change the counterpressure of the pilot, whereas previously it was used to change the control-valve position. And maintenance is reduced, since the regulator's moving parts are not exposed and are fewer in number, compared with a conventional control valve.

Grafe feels that the advantages of improved process control and less maintenance make the installation of the regulator attractive on a trial basis. The regulator is less expensive than an automatic control valve and positioner and could be used as a substitute without replacement of the existing steam system's pressure reducing station.

Clean Sweep Savings: However, major cost savings result from using regulators when a new steam distribution system is being installed or an old system is revamped, according to L. R. Driskell, principal engineer of instrument department of Blaw-Knox Co.'s Chemical Plants Division. Driskell, who worked out typical chemical plant examples for a 150-psi. main steamline supplying four process branch lines with 32-psi. (terminal pressure) steam, calculated savings of over 40% by equipping with a regulator system instead of the conventional system with pressure reducing station and automatic control valves.

The main cost saving was in piping—about $5,000 lower than for the conventional system piping, which would cost over $12,000 if carbon steel were used, $11,600 if cast iron were used. For example, the conventional system, which would reduce the 150-psi. steam to 40 psi. for distribution, would require 170 ft. of 8-in. piping, 313 ft. of 6-in. piping. The new regulator system for these same sections would use 4-in. and 3-in. piping. And, because the lines are smaller, insulation costs would be cut by one-third.

The savings in total cost of the regulators over cost of automatic control valves was 75% ($853 vs. $3,022) for carbon steel units and over 80% ($397 vs. $2,400) for cast iron—the result of using only four regulators (one for each process steamline) instead of five automatic control valves

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(one for each process line, plus one for reducing main-line pressure) and the smaller valve sizes of the new regulator system.

Design Angle: Driskell points out that additional cost savings may be possible in heating-equipment design when the new distribution system is used. In a conventional distribution system, the safety valve on the reduced-pressure header normally acts as the overpressure protection for all of the equipment being fed. This means that the maximum allowable working pressure of each steam-using unit below the header must equal or exceed the "protective" setting of the header's safety valve.

Therefore, if the safety valve at the header is set for 45 psi., all of the process heater units must be designed to accommodate at least 45-psi. steam (unless a pressure-limiting controller and safety valve are added) —even though the units may require steam at only about 10 psi.

Using the new system with regulators, steam pressures at point of use can be within 10% or 5 psi. (whichever is greater) of the equipment design pressure. Consequently, equipment can be designed for lower pressures or with less heating surface.

Another potential saving: failure of a conventional system's reducing station knocks out all users of the distribution system. A Spence regulator failure knocks out only the individual process unit.

Limitations: Grafe and Driskell cite some limitations of the new system —e.g., it cannot be used with complete open-loop control, which represents only a few applications.

If a process requires constant steam flow regardless of load changes, an increase in load, which would condense more steam, would cause the regulator to increase the flow of steam—an action that would not be wanted. And, in some plants, low-pressure steam is produced in the process units or steam turbines, which would make elimination of a low-pressure steam system undesirable.

And, despite the broad range of conditions for which the air-loaded, steam-piloted regulator can now be offered, there are still some gaps in the operating range. But in process cases where it will fit, the regulator seems to be a welcome addition for cutting steam distribution costs.

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MISCELLANEOUS

To Employers Who Advertise for Men: The letters you receive in answer to your advertisements are submitted by each of the applicants with the hope of securing the position offered. When there are many applicants it frequently happens that the only letters acknowledged are those of promising candidates. (Others do not receive the slightest indication that their letters have even been received, much less given any consideration.) These men often become discouraged, will not respond to future advertisements and sometimes even question if they are bona fide. We can guarantee that Every Advertisement Printed Is Duly Authorized. Now won't you help keep our readers interested in this advertising by acknowledging every application received, even if you only return the letters of unsuccessful applicants to them marked say, "Position filled, thank you." If you don't care to reveal your identity, mail them in plain envelopes. We suggest this in a spirit of helpful co-operation between employers and the men replying to Positions Vacant advertisements. Classified Advertising Division, McGraw-Hill Publishing Company. "Put Yourself in the Place of the Other Fellow."

Opportunities-business; personal or personnel; financial; equipment; etc., may be offered or located through the Tracers Section of Chemical Week. For more information write to: Classified Advertising Division, Chemical Week, Post Office Box 12, New York 36, New York.

POSITIONS WANTED

Common Market Technical Representative. Businessman-chemist to thoroughly learn your specialty before establishing in Europe. 4 years abroad, French, German, single, 34, $9,000. PW-7316, Chemical Week.

POSITIONS WANTED

Technical Sales-degree, 35, married. Excellent background in detergents and detergent sales. Prefer Midwest but willing to relocate. PW-7346, Chemical Week.

Chemical Salesman-Seeks responsible sales position, age 34, degree, diversified experience in plastics, solvents, heavy chem., fert. raw materials & proprietary compounds. Prefer Mid-West location-salary + comm. PW-7301, Chemical Week.

Your Organization-is it complete? Are you expanding it? Making replacements? Naturally, you are anxious to secure the most suitable man or men available. You want men with the special training that will make them an asset to your organization. You can contact such men through an advertisement in this Tracers Section of Chemical Week, Classified Advertising Division, Chemical Week, Post Office Box 12, New York 36, New York.

SPECIAL SERVICES

Hard-To-Find Chemicals located by specialists No listing charge. Chemsearch Associates, 2090 Peralta Way, Hanford, California.

The Consulting Engineer. "By reason of special training, wide experience and tested ability, coupled with professional integrity the consulting engineer brings to his client detached engineering and economic advice that rises above local limitations and encompasses the availability of all modern developments in the fields where he practices as an expert. His services, which do not replace but supplement and broaden those of regularly employed personnel, are justified on the ground that he saves his client more than he costs him."

EQUIPMENT FOR SALE

Multi-million dollar chemical plant at North Little Rock, Ark. Stainless Steel & glass-lined equip. Send for detailed circular. Perry, 1415 N. 6th St., Phila. 22, Pa.

Buflovak 42" x 120" double drum dryer, ASME code drums 160 psi WP, complete. Perry, 1415 N. 6th St., Phila. 22, Pa.

Pfaudler 1250 gal. blue-glass lined jacketed reactor, 72" x 72", Agit. Perry, 1415 N. 6th St., Phila. 22, Pa.

1350 gal. T347 Stainless pressure tanks, 4' x 14', dished, ASME 60 psi WP, coils. Perry, 1415 N. 6th St., Phila. 22, Pa.

Model U6 Fitzmill Granulator 10 HP motor, stainless steel, variable screw feed, 48" legs completely equipped, perfect condition, $3900. Embossograph Process Co., Inc., 3720 14th Ave., Brooklyn 18, N. Y. ULster 4-6773.

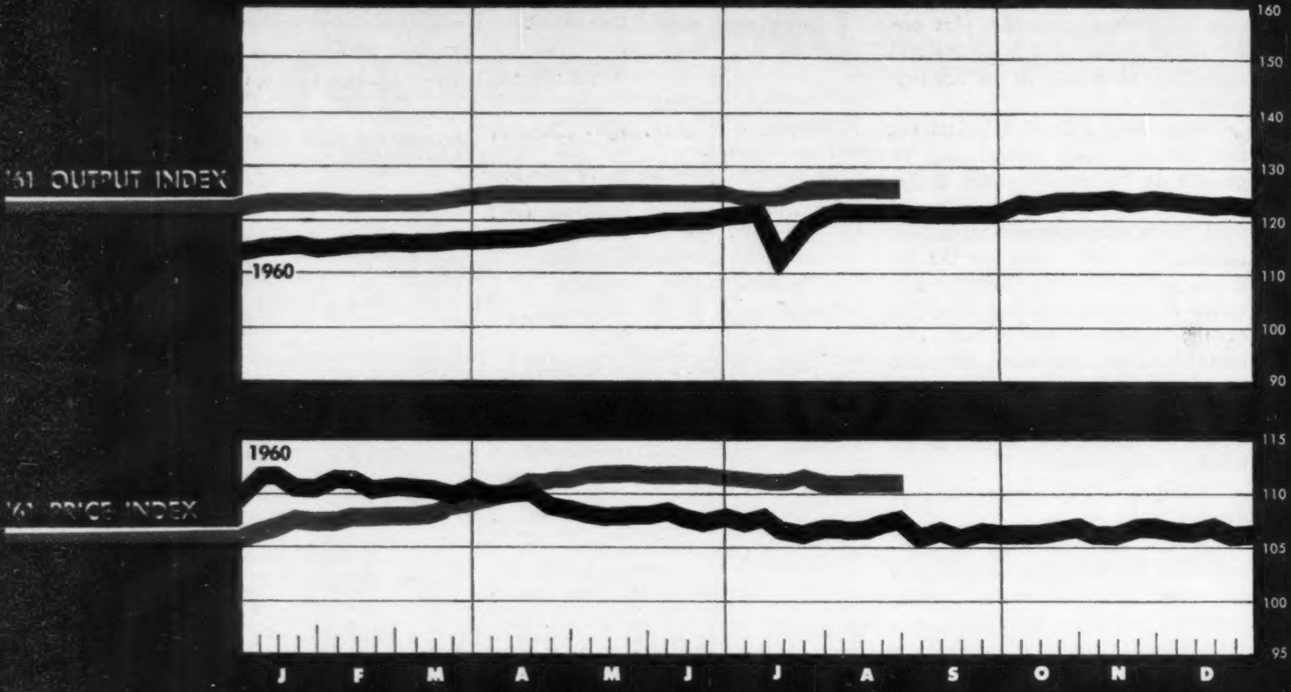
For Sale:—Over 80,000 Gallons A. O. Smith Blue Glass-lined Storage Tanks still erected in closed Newark, New Jersey brewery. Available at once. Arrange for inspection now. For details, contact Frank Boitz in Newark at Bigelow 8-6161 or Bigelow 8-3400 or write c/o P. O. Box 3055, Newark 3, New Jersey.

CHEMICALS WANTED

Surplus Wanted—Chemicals, Pharmaceuticals Oils, Acids, Plasticizers, Resins, Dyes, Solvents, Pigments, Etc. Chemical Service Corporation, 96-02 Beaver Street, New York 5, N.Y. HAnover 2-6970.

This Tracer Section can be used whenever you are looking for or offering Equipment, Plants, Supplies, Chemicals, Opportunities, Special Services. The rates are low—just call or write Classified Advertising Division, Chemical Week, P.O. Box 12, N. Y. 36, N. Y. LOngacre 4-3000.

BUSINESS BENCHMARKS



AUGUST 26, 1961

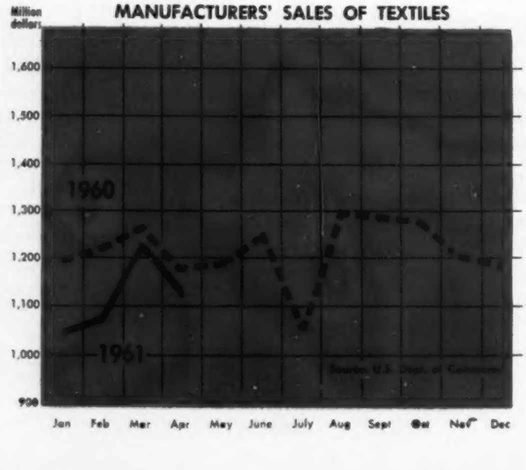
WEEKLY BUSINESS INDICATORS	Latest Week	Preceding Week	Year Ago
Chemical Week output index (1957=100)	125.4	125.1	125.0
Chemical Week wholesale price index (1947=100)	111.1	111.0	108.5
Stock price index (12 firms, Standard & Poor's)	55.68	55.45	48.64
Steel ingot output (thousand tons)	1,910	1,850	1,525
Electric power (million kilowatt-hours)	16,080	16,137	15,037
Crude oil and condensate (daily av., thousand bbls.)	7,045	7,024	6,834

EMPLOYMENT INDICATORS (thousands)	Latest Month	Preceding Month	Year Ago
All manufacturing	15,952	15,713	16,422
Nondurable goods	6,800	6,685	6,918
Chemicals and allied products	883.6	881.4	877.8
Paper and allied products	557.0	547.4	567.0
Rubber products	248.8	243.5	258.1
Petroleum and coal products	221.0	218.3	232.5

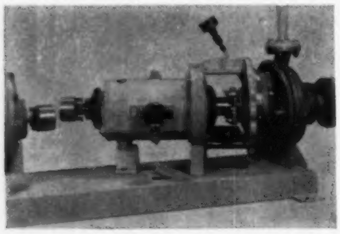
CHEMICAL CUSTOMERS CLOSE-UP

FACTORY SALES OF PASSENGER CARS

MANUFACTURERS' SALES OF TEXTILES



Some fundamentals of centrifugal pump design for the chemical process industries



The primary pump problems in the chemical industry involve materials of construction, gland and seal leakage, and bearing failure. Unless pumps are specifically designed for chemical service, unless materials of construction are selected to handle specific corrosive conditions, unless maintenance is simple and parts standardization is high your pumps may be the biggest headache in your entire operation.

Materials of construction

DURCO has spent 50 years developing alloys and materials for practically any corrosive service.

Pumps and pump parts are available in fourteen standard and many special corrosion resistant alloys. All of these are cast in the Durco foundry to retain complete responsibility for the excellence of your equipment.

Chlorimet 2	Ductile iron
Chlorimet 3	18-8-S (304 s.s.)
Durco D-10	18-8-S-Mo (316 s.s.)
Durichlor	Monel
Duriron	Nickel
Durimet 20	Ni-Resist #2
Durcon (modified epoxy resin)	Inconel

Specific design for Chemical Service

Shaft run-out and deflection have been the major causes of seal deterioration, gland leakage and bearing failure in pump operation. DURCOPUMPS have shafts with diameters substantially larger than those traditionally used in centrifugal pumps. Shafts have a maximum run-out of .0015″ with centerline deflection of no more than .005″ at the impeller under maximum hydraulic load. Bearing housings are a thru-bore design, assuring perfect alignment. With this minimum deflection, packing and mechanical seals last far longer under operating conditions.

Long bearing life

Reduced shaft deflection has made it possible to build Series H pumps for 3500 rpm operation. Heavy duty bearings are selected for a minimum life of two years at this speed under maximum operating stress. The normal life is many times greater than this. Bearings are sealed against oil leakage and external contamination by Durco designed Teflon* lip seals.

Many additional features designed into the Series H Durcopump give maximum flexibility in service. The casing is end suction, top center discharge and self venting with integral feet. Since it uses a rear cover closure, the pumping unit can be removed without disturbing the casing or disconnecting the process piping. *No drilled holes enter the casing at any point.*

Impellers are threaded into the pump shaft, eliminating the impeller nut, and thereby greatly reducing the required NPSH. Head and/or capacity for any pump may be changed merely by changing the impeller diameter. A horizontal seal ring permits adjustment of the impeller without increasing stuffing box pressures.

By the use of an adapter between the casing and bearing housing, eight pump sizes can be mounted on one bearing housing, utilizing one shaft. As a result, just four bearing housings will handle the complete range of Durcopumps. Since each is engineered for the maximum pump size in its range, most Durcopumps will have a built-in safety margin far beyond normal service requirements.

Simplified Maintenance

Simplified, low-cost maintenance results from maximum parts interchangeability and minimum down-time.

Bearing housings, shafts, and frame adapters on all Durcopumps are interchangeable over a wide range of pump sizes. A complete range of pumps can be maintained in your plant with a surprisingly small spare parts inventory.

The foot mounted reverse casing design was first applied to chemical pumps by Durco. This design holds process down-time and maintenance costs to a minimum. Pumps are designed for single trade maintenance. A millwright or mechanic can remove all rotating parts of a Durcopump from the casing in a matter of minutes. Neither the piping nor the motor need be disturbed. This means that rebuilt or new assemblies can be installed with little or no realignment.

Durcopumps are available in sizes from 1″ x 1″ to 10″ x 8″ with capacities from ½ GPM to 4250 GPM, and heads to 345 feet. Durco also manufactures self-priming and submerged pumps for most corrosive services.

You will find that your local Durco Engineer is a reliable source of information on pumping problems and equipment.

**DuPont registered trademark*

THE DURIRON COMPANY INC., *Dayton, Ohio / Serves the process industries*

DURCO